New Horizons for the Oilseed Industry

PROCEEDINGS OF THE TWENTY-THIRD OILSEED PROCESSING CLINIC, New Orleans, La., March 4-5, 1974

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FOREWORD

The Oilseed Processing Clinic is sponsored jointly by the Southern Regional Research Center and the Mississippi Valley Oilseed Processors Association, Inc.

The presentations at this Clinic were centered around the theme, "New Horizons for the Oilseed Industry." The views of the USDA regarding the domestic and worldwide oilseeds situation were the keynote presentations. EPA requirements in oilseed processing and quality control of oilseeds were the subjects of the two panels. Other topics presented dealt with oilseed storage, linters removal, and the competitive position of oilseed products.

This proceedings reports the statements presented by the various speakers during the 1974 Clinic.

Mary E. Carter, Director
Southern Regional Research Center

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PANEL: PROGRESS AND PROSPECTS IN MEETING EPA REQUIREMENTS: DISCUSSION OF DUST CONTROL AND INCINERATION

By Billy L. Shaw[1]

Much concern has been expressed as to the type of dust control equipment to use in our industry. Individual companies are using several approaches to this problem.

The Southern Cotton Oil Company, Incorporated has directed their research on this problem on two different types of equipment--the Cam-Vac filter unit and high efficiency pressure (HEP) cyclones.

The main point of interest in testing the Cam-Vac type filter unit is the high volume of air per square foot of area. In tests that have been made the range is 160 to 120 cubic feet of air per foot of filter media.

These figures appear more favorable than do results of 8-15 cubic feet of air per square foot on bag type units. We have no figures on this with the exception of what the manufacturer might guarantee. It is my understanding that some will not sell the bag unit for use on lint.

I would like to discuss and compare the operation of the Cam-Vac unit as back up to old style collectors and HEP cyclones as a replacement, efficiency and price wise.

The results of tests on the filter unit and HEP cyclone are indicated here.

Dacron Felt (Recycle In)

7500 ACFM - .024 grains/cu ft = 0.266#/hr/linter

Polyester (Recycle In)

7100 ACFM - .028 grains/cu ft = 0.27#/hr/linter

Polyester (Recycle Out)

6300 ACFM - .044 grains/cu ft = 0.37#/hr/linter

Rayon (Recycle In)

5800 ACFM - .018 grains/cu ft = .149#/hr/linter

#65 HEP Cyclones (20 Linters)

27200 ACFM - .019 grains/cu ft = .2#/linter/hr

You will note the facts in parenthesis, (Recycle Out) - (Recycle In), the recycle is the discharge from the top of the small HEP cyclone which is not loaded efficiently. It was thought that the dust loading would tend to plug the filter cloth at an increased rate, therefore, the tests with the recycle in and out. Apparently the best result is with the recycle in to increase the filter loading.

The best result here is on a rayon media with a lower air loading per square foot than the other tests. The possibility here is that an air to cloth ratio somewhat lower than the 160 cubic feet per square foot may be necessary.

It would be my suggestion that if this unit is tested again that the vacuum unit be slowed to give a greater lapsed time between sweeps of the unit. The results apparently bear this out.

Estimated cost of 3 unit Cam-Vac system handling 20 linters @ 28000ACFM - 1973 prices - 192" Standard Collector . . . . $36,727.

[1]Engineer, Hartsville Oil Mill, Hartsville, South Carolina 29550.

Cost 20 linters on HEP cyclones - 1973 prices.

4 - #65 HEP	$28,549
6 - #47 HEP	$34,957
8 - #32 HEP	$36,357

I would like to give my thoughts on the application of HEP cyclones.

It has been my thinking that if we cut the size of the cyclones and yet maintain the inlet velocity we would increase the efficiency of the cyclone. The increase would be due to the greater centrifugal force on the particle created by the change in diameter of the unit. We have proven that the increase in velocity does improve efficiency at the cost of horsepower.

I have taken the best results of tests on the Cam-Vac unit and the HEP cyclone and placed them in a material balance situation.

A mill operating at a capacity of 10 TPH or 240 TPD would have the following situation:

@ 5 T per linter	=	50 linters
@ 10 TPH thru lint room - code allows	=	19.8#/hr loss
@ .27#/linter	=	13.5#/hr
@ .37#/linter	=	18.5#/hr
@ .15#/linter	=	7.5#/hr
@ .2#/linter	=	10.0#/hr

All of this gives an idea of the results and possible applications at this time. It does not give an idea of what future requirements will be.

<u>Waste Burners</u>

Most standards restrict the emission from existing waste burners to a Ringleman 2 or 40 percent opacity. All of the emphasis has been to make waste burners obsolete. Louisiana requires that if you discontinue burning, you will not be allowed to reinstate this process.

Let us look at the means of disposal and the economic values involved:

1. land fill
2. mulch
3. use of waste in generation of useful products
4. improvement of incineration in tee-pee or jug burners

The problem with land fill and mulch are multi-fold:

1. areas are not readily available;
2. farmers are not interested in putting weed seed back on their land (nut grass in peanut area);
3. bins and dust control systems for trash do not adequately control the problem that they are to solve;
4. the cost of handling increases continuously. One dollar per bale or ton of peanuts shelled is conservative. This may be a large part of the profit picture at times.

The use of waste to generate useful products is one area that needs much research and development.

A # of coal = 13,000 BTU

A # of peanut hulls = 9,000 BTU

A # of gin waste = 7,000 BTU

A # of wood waste = 8,000 BTU

The present method of approach is to improve incineration in existing tee-pee or jug burners. This is the most economical method. If your gin customer has one, it can be made efficient with minor changes if approved by your state agency.

The continued efficient operation of an incinerator depends on ash disposal or cleanliness of the unit. This definitely increased or decreased the efficiency.

Most incinerators were set up to have an extreme amount of excess air. The large excess cooled the stack gas to the point that a huge plume of smoke was emitted. Our approach to this is directly opposite or only enough for good combustion.

The generally accepted procedure is to put air into an incinerator under fire air from a fan over fire air by fan or tangential entry at the side of the burner. Literature documents that excess air should be from 200 to 500 percent of theoretical. The theoretical air is from 5 - 7 #/# of material consumed. General combustion equations are equated to a rule of thumb calculation at approximately 700# or air per million BTU of output of the burner.

The theoretical under fire air has been evaluated to 10 percent of the over fire air. We have placed approximately 50 percent of the theoretical to burn completely (6#) as under fire air.

5000# material per hour = 30,000#/hr

3000 cu ft/min = 13,000#/hr

The thought was to completely limit as near as possible any over fire air due to leakage by scaling. This is more practical in a jug burner where it can be completely sealed except for cyclone inlets. The discharge stack is restricted to act as a fixed camper which restricts the input of over fire air. The temperature of the T-P discharge is around 900° recorded (as a state requirement). The discharge of the jug is 1000° F. Those temperatures fit the requirements of the state agencies.

PELLETING COTTONSEED HULLS AS AN APPROACH TO AIR POLLUTION PROBLEMS AND WATER SCRUBBERS AS AN APPROACH TO AIR POLLUTION

By Phil Strid[1]

PELLETING COTTONSEED HULLS

Pelleting cottonseed hulls is not new, but to make pellets without a dust pollution is. In our operation we pellet hulls direct from plant operation at a rate of 7 to 8 tons per hour. This eliminates handling bulk hulls which we all know creates a dust problem and hull spillage. Bulk hulls have a density of 15 1/2 to 16 1/2 pounds per cubic foot. Pelleted hulls have a density of 36 pounds per cubic foot. Pelleted hulls can be loaded into hopper rail cars or trucks without a dust problem, and there is no problem to make weight limit. This enables us to ship hulls to any destination.

To process 7 to 8 tons per hour we require 250 horsepower on the rotating die, 10 horsepower on the pellet machine feeder and an additional 20 horsepower on the hull conditioner.

Moisture is added to the hulls in the conditioner to 14%. The only additive that is used is the small amount of tergital (wetting agent) used to help the moisture penetrate the hulls. Hull pellets from the pellet cooler to storage is 9% moisture. Dust from this process is nil, also storing in warehouses or tanks, the product will flow freely and dust free. The one problem we have

[1]General Superintendent, Ranchers Cotton Oil, Fresno, California 93745.

in processing hulls through the pellet machine is that the hulls break down in their structure because of temperature and pressure and release an ascetic vapo This vapor is corrosive so it has to be removed before the product is discharge into the cooling system. This is one way of handling hulls without a dust prob- lem. If there is a demand for pelleted hulls, it would be worth the expense to install the equipment for a dust free operation. We have very few processes that can be installed in a plant that will produce a product and also reduce the dust contamination in operation.

AIR WATER SCRUBBER

Using water to remove dust particles from an air flow has always been a problem. You clean the air with water, but you start another pollution problem disposing of the water that is to clean the air. Our theory has been to chemically treat the water so the water can be recycled. The experimental scrubbing system we are working on is handling 22,000 C.F.M. of air from the third cut linter cyclones. There are two scrubbing towers on this system - each tower handling 11,000 C.F.M. of air. The towers consist of a series of baffle plates set on a 45 degree angle. To quarter the air stream there are three sets of baffles in each tower to change direction of the air flow. The baffle plates increase the surface area for the air and dust particles to make contact. Dust in air will not separate by going through water, it takes impact or rubbing action to separate the dust particles. The water is recycled from the scrubber tank to the top of the two towers at a rate of 30 G.P.M. of water to each tower. The water is deluged into the tower without sprays. This prevents any problems with spray head plugging. The incoming air from the balancing fan disperses the water over the baffle plates in the tower. A drag chain with rubber paddles cleans the bottom of the tank and conveys mud up the incline and discharges.

Chemicals are used to congeal the dust particles so they will settle to the bottom of the tank. There are three types of chemicals used:

1. Tergital HP-100 (wetting agent). A chemical that will lower the surface tension of water so that other particles are easily captured.
2. Arosurf. A chemical that lowers the surface tension of fats and oil. Dust particles from the third cut cyclones contain approximately 2% oil.
3. Ferric Chloride. A chemical that is a coagulant. The chemical will capture suspended particles in a heavy floc and separate from water.

Lint fiber is impossible to remove by chemical treating. It will float to the surface and collect at the dormant section of the tank. This material can be removed from the scrubber mechanically.

We feel that by chemically treating water we are able to recycle water and remove dust particles from the air discharge systems. This unit is to be re-designed to meet the dust standards.

A NEW APPROACH TO HULLING AND SEPARATING AS IT RELATES TO AIR POLLUTION

By A. L. Vandergriff[1]

In the late 1950's and early 1960's, safflower developed into an important oil seed crop for us as it did for many other California and Arizona growers. It filled a need for an oil seed crop, a need which was augmented by the dwindling cotton acreage under government restrictions. For us, it provided a third crop to go with our cotton and feed grain and an ideal crop rotation plan.

In the early stages of safflower production and processing, there was much concern about a market for the low protein meal produced. Without removing some of the hulls, the protein level was in the range of 20 to 24%. This market concern resulted in intensive efforts to remove some of the hulls and bring the protein level up without loss of protein or oil with the hulls. Attempts were made with varying degrees of success to separate some of the hulls after oil extraction. However, most of the early efforts were aimed at decortication. Generally the methods of cracking the safflower seed and screening the hulls produced a lot of blinded screens and conveying systems plugged with sticky meats.

It was at about this point in the industry efforts that Boswell asked me to take a look at the possibility of safflower decortication. I had one advantage probably, I didn't know that others had already found it couldn't be done. After a few months of intensive effort, we began to realize some encouraging results. Mel Connley arrived on the scene while we were still in the experimental stage and this was fortunate! If the project proved successful, I could still take some credit for it, but if it failed I could say "Mel, you made a good try."

Mel proved equal to the task and then we had to decide if we had the nerve to tear out our cottonseed huller and separating room and replace it with decortication equipment for both cottonseed and safflower, or should we settle for a separate decortication room for safflower.

We chose to replace the huller and separating room with a new decortication plant. With the help of Floyd Davis of Industrial Metal Products who made the decorticating rolls for us, Southwest Engineering who supplied the Sweco screening units and worked with us on the blinding problems, we were able to put together a rather satisfactory operating plant. Our own little Engineering Department did all the engineering, both layout and details, as they do on most all of our projects.

Although my topic was to be "A New Approach to Hulling and Separating as it Relates to Air Pollution," I am sure our moderator will agree that he employed a rather sneaky way to get us to talk about our hulling and separating by relating it to dust control. Although this installation was made quite sometime before we felt the pinch of OSHA and EPA, our own state regulations, along with our desire to provide a comfortable place to work, encouraged us to install good dust control methods as well as safety guards. We will go into more detail on this as we discuss the operation of the system.

[1]Vice President and Technical Advisor, J. G. Boswell Company, P.O. Box 457, Corcoran, California 93212.

The decortication is divided into four units, each having a capacity of about 85 tons/day on cottonseed and about 75 tons/day on safflower seed. It is quite common for manufacturers to refer to cracking units as decorticators; however, we refer to the system of cracking and separation as decortication. The cracking units we use are most recently described in Industrial Metal Products Co., Bulletin D 569, and I am sure Mr. Floyd Davis won't mind my mentioning this--even if he does describe them as decorticators. These units are manufactured with rolls for cracking either cottonseed or safflower and since they are described rather well in the above-mentioned bulletin I will not go into any more detail.

The cracking units are well sealed and there is very little impact between the seed and the rolls so there is very little dust emitted. Little or no uncracked seed gets through the unit, therefore, it is unnecessary to have a rerun system.

As stated above, we have four units of decortication, with each unit being fed from an overhead conveyor distributing seed across the vibrator feeder hopper above the cracking units. I will run through the rest of the process briefly and then discuss it more thoroughly as we look at the slides I have.

From the cracking unit the material is delivered to the first 60" Sweco stainless steel unit with 8 mesh stainless steel screens and "Anti Blinding Sliders." If you haven't had experience with the sliders, they are very interesting. They are short pieces of plastic pipe which fit under the screen and are supported by an open perforated deck. The open ends of the tubing are up and down with the ends having only a small clearance between the screen and the deck. The action of the screening unit keeps these sliders in constant motion and they are very effective in preventing blinding even with the sticky safflower meats.

The eight mesh screen drops a high percentage of the meats through into a common meats conveyor headed for the expellers. The hulls are the overs and they are dropped into a second Sweco unit on the next floor down. This unit is equipped the same as the first stage where again the bottoms, or meats, go into the meats conveyor. The overs, or the hulls, are fed from this unit into an air classifier through a rotary air lock. This classifier makes a density separation dropping out any meats too large to go through the 8 mesh screen. A prime function, however, of the classifier is to control the protein level of the meal. The amount of hulls separated from the meats is controlled by adjusting the air velocity in the classifier tube. Our most common method of operation on safflower is to produce a mill run protein of about 30% which splits about 50-50 into 20% and 40% protein meal in the meal processing facility. At higher percentages of protein meal, the loss of protein and oil in the hulls may become a significant factor.

The bottoms from the classifier go into the cottonseed meats conveyor while the tops are pulled into a bag-type air filter where the air is separated through the bags and the hulls dropped into a hopper. The hopper has a screw conveyor in the bottom which conveys the hulls through a hull plug into a third Sweco unit for a final screening before they are delivered to the hull pile. The bottoms again go into the meats conveyor.

Each bag filter is equipped with 52 dacron bags 6" in diameter by 48" long. The air cloth ratio is about -4 to 1. The bags are replaced about every four months. We have an extra set of bags and they are washed for reuse when they are replaced.

Before discussing the dust control further, let's go back and mention the cottonseed flow through the system. It is the same as safflower with the air classifiers acting as the protein control for the meal. If the market requires 50% protein meal, the mill run protein is 44% and this is split into 41% and 50% in the meal processing room.

STORAGE OF OILSEEDS

By Vernon L. Frampton[1]

(ABSTRACT)

Only a few of the existing species of seed are used by man as food for himself or feed for his animals. He stores edible seed to tide himself over to the next harvest. Seeds under natural conditions are remarkably resistant to deterioration, but seeds stored in bulk are not in a natural environment. Unless care is taken to insure proper storage, deterioration of the seed can be very rapid and costly. Seeds in storage deteriorate because of the action of a succession of populations of storage fungi that produce on the seed toxic metabolites of astonishing and inordinate toxicity. Seeds in storage also deteriorate because of the actions of storage insects that consume substantial portions of the seed (especially the seed embryo) and also leave on the seed deposits of insect frass, insect secretions and metabolites, decayed insect bodies, and other materials. Seeds deteriorate also because of the depredations of rodents that contaminate the seed with urine and feces and introduce insects and pathological bacteria.

Deterioration of seeds in storage caused by fungi and insects is associated with pockets of wet seed, and the deterioration is associated with high temperatures within the moist pocket. Water and heat are products of respiration of fungi and insects, and, with the increasing temperature (with an upper limit) and moisture, respiration is enhanced and insects and fungi proliferate, with the production of more moisture and more heat. The appearance of hot spots in the bulk of stored seed is not an indication that deterioration has been initiated, but it is rather evidence of the final and violent effects of fungal and insect growth and of spoilage of the seed. Such seed should not be used for food or feed. Spoilage of seed in storage can be avoided if (a) dry seed is stored, (b) condensation of moisture to produce a wet area is prevented, (c) insects are destroyed by fumigation, and (d) rodents are denied access to the stored seed. Research to reduce the extent of spoilage of stored seed might be directed at determining how germination of spores of storage fungi can be avoided even when the seed is moist and temperatures are favorable for spore germination.

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QUALITY CONTROL OF SEEDS COMING INTO THE MILL DURING STORAGE AND GOING INTO PROCESSING

By Leslie M. Reid[1]

I want to follow cottonseed from the time it reaches the mill to the cleaning room and I believe that is where the next panel member picks up.

First of all, a certain amount of preplanning and preparation needs to be done before an unloading period. With all of this behind you, it can still be pretty wild during the unloading period. The storage units hopefully have already been emptied or at least most of them with sufficient lead time to clean them out and sweep down and to treat with an insecticide, a residual insecticide, so that the job won't be so great at this close proximity to the unloading period.

After the final cleanup and sweepdown, you should check the cooling system to make sure everything is working properly. Close the unit for the exclusion of birds and rodents. That is becoming ever more important. There is another thing I might mention. If this storage unit has been used during the time it was devoid of seed and used for storage of products, it should have a good cleaning, an excellent cleaning, and should be treated before you go into it with the new seed.

The next thing, let's made sure that the sampling equipment is in good shape. Have a moisture meter that has been checked out. I am sure there are several moisture meters, but I might mention one that we have been using. It is the Steinlite Model DL with compressor block, which we have found in our use has had a standard deviation of approximately 0.3 of one percent.

Make sure the shaker is in good shape, clean, the metal is not sagging, so that you can do a good job of getting an official sampling. Have your sample cans and plastic bags in good order.

Temperature control equipment, after the seeds are in the unit, you should have thermometers and cases on hand, pipe, fish tape, plastic tape and twine.

Now the seed starts coming in. At the sample station you check the moisture and determine the disposition of that seed. If it is low moisture, it can go to permanent storage. If it is high moisture, it can go to the high capacity cooling system. I will get to that again a little later. It can go to temporary storage or direct to the mill if it has started up. For hot and sour seeds, do like Ralph says, fan them and feed them and they go through.

As soon as enough seed is in the unit, selectively isolate the cooling unit under the seed pile and start the cooling fan. Expand the cooling as the size of the seed pile grows. Pipe and install thermometers within one week of the filling of the unit. Use probes on temporary storage but make sure that they are not getting away without your knowledge. In seed conditions, let's keep records of temperatures of each unit and if the temperatures are above 80 degrees, read them daily. If the maximum is between 70 and 80, read every second day. If below 70 degrees, once a week.

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[1]Section Head, Mill Service and Standards, Buckeye Cellulose Corp., Memphis, Tenn. 38117.

On running of cooling fans, I would say run continuously if you have a maximum temperature of 90 degrees or above, or if it is just below 90 and rising. If the maximum is 80 to 90 degrees, turn off the fans only during rain. If the maximum is below 80, run selectively, depending upon the maximum temperature and the average temperature. If a hot spot won't turn around, concentrate cooling on that spot. If that doesn't turn it around, you are going to have to transfer or crush that seed.

There are some other guidelines that I think are worth mentioning. One is the high capacity cooling system I mentioned a little while ago. Due to the rapid harvest of high moisture seed, particularly in the Valley, we have found it necessary to soup up the cooling systems so that you get a flow of approximately five cubic feet per minute per ton of seed. I think most of the regular cooling systems handle about two to three cubic feet per ton of seed.

How much cooling should you do? If you are going to keep the seed beyond March 1st, I would say get the seed between 40 and 50 degrees. Before March 1st, 50 to 60 degrees. This may require from 1,600 to 2,400 fan hours, but I think you can pay for it without any problem.

In feeding seed from storage, safety is one of the prime considerations. Preplan your method of feeding out. School your employees on the dangers and safety measures to overcome these problems. You can do all this but make sure to follow up with good supervision. Make sure that your rules and regulations are being followed. In some types of units, hand feeding is necessary for a while, but as soon as possible you get in with a front-end loader, a hopper with feeders or other mechanical means, since seed feeders as we used to know them are going out of style.

In seed cleaning, about the first thing we think of is removing the wet stringy seed that won't go through, bolls, sticks and such as that, besides shoes and brickbats. In recent years we have been discarding a lot of good seed with this practice and sometimes that will amount to .25 to maybe one percent of the seed coming to the cleaning room and you just can't afford to lose that much seed, so I think you should salvage those seeds. Send this fraction to either beaters or extractor feeders to reclaim this seed. You not only paid $110 to $125 for a ton of seed but you have already made a further investment in hauling that seed in but storing and keeping it. If you figure the value of the products, it is at least thirty percent more than what you have in the seed, or something in that neighborhood. I think it would be safe in saying some of our mills are less sophisticated than the one Mr. Vandergriff showed us this morning and we don't have the luxury of having precleaned seed.

QUALITY CONTROL OF OIL SEEDS BEING PROCESSED IN THE MILLS

By John Howard[1]

(Presented by James C. Holloway[2])

This means, to me, that the equipment in the mill must be operated in such a manner that the best grades of products are obtained at the maximum capacity. This is easier to put into words than it is to perform.

Before the desired results are achieved, each piece of machinery in the mill must be kept clean, must be kept in good repair, and must do the work for which it is designed. Then the machinery is functioning properly, the flow of materials to each machine must be coordinated. The flows between the departments must also be coordinated.

A supply bin or tank to feed seed from storage to the cleaning room is essential. The conveyor feeding the seed cleaners should carry a little surplus seed to spill into a conveyor that returns the surplus seed back to the supply bin. The reason for the surplus flow of seed is to allow the setting of each seed cleaner feeder at the minimum rate required for the needed capacity. A steady flow is thus provided with the thinnest mat possible on the seed cleaner shakers. It is obvious that cleaner seed will go to the next department.

A good operation in the separating room requires a lot of thought and a lot of attention. Shakers must have screens with proper sizes of perforations. Number of huller breast bars and huller speeds need to be adapted to the type seed being worked. Dry seed need fewer bars and slower speeds. Operation on thin hull seed could be different from that on thick hull seed. The greater the number of black seed and meats in hulls going to the hull and seed separators will result in a larger number of seed and meats in hulls going to the hull house. The more meats picked up by scalpers will cause more meats to be in finished hulls.

The operation of a prepress room and expeller or screw press room would be about the same except for cooking conditions. An unrolled meats supply tank is preferred. A supply tank of rolled meats is not as easy to keep clean, does not feed as readily and could cause a free fatty acid build up. The supply tank should be small and should empty completely. The best cooking conditions should be established. The cookers should be kept full. Steam traps, steam regulators and thermometers should be kept in good condition. Cookers should be checked inside for steam leaks at regular intervals. If press room work goes bad, one of the first things to look for is such a steam leak.

Residual oil in prepress cake should be reduced to as low a point as is practicable--probably down to 9% to 10%. This results in lower refining loss in the combined oil, lower residual oil in solvent meal and a lower solvent loss.

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[2]Superintendent, The Southern Cotton Cotton Oil Co., Inc., P.O. Box 856, Greenville, Miss. 38702.

The rest of this discussion will apply mostly to cottonseed operation.

How often have you seen some of the first cut and second cut linters at the nds of the lines running without seed? This means that it has been necessary o adjust the linters to accomodate fluctuations in flow. The ones that are elinting must have denser rolls for capacity which produces more hull pepper nd which in turn reduces the quality of the lint produced. You can say to ourself that the lint cleaners will take this extra pepper out. Don't you elieve it! A lint cleaner performs like any other type cleaner. The higher ercentage of trash in the material going to a cleaner results in a cleaned aterial containing relatively higher amounts of trash.

A seed overflow bin for the first cut linters will do much to even out the low of seed through the lint room to allow best possible settings on the machin-ry to improve quality of both first cut lint and second cut lint.

A large supply tank to feed black seed to the separating room is of much enefit. One of the best operations ever seen had enough black seed storage allow operation of the lint room for five days while the separating room and ess room ran seven days. At the end of the season's crush, the linterman uld come to the door and say, "See you next fall." The plant was clean and l the seed house, cleaning room, lint room, and baling room machinery had been paired and was ready for a new season.

The lowest temperatures consistent with good operation in the solvent plant ould be used to produce oil with low red color and to produce high quality al.

Most of you probably have better ideas of quality control in processing of ed. One thing is sure--a little thought and study of each operation will pay g dividends.

PRODUCT QUALITY OF CRUDE MATERIALS BEING PREPARED FOR FURTHER PROCESSING BY OTHER MILLS, AND REFINING OF THE FINAL PRODUCT

By Dan L. Henry[1]

One difinition of an expert is one who has his thoughts organized and has epared slides. I feel that I do not qualify on either of these counts. I re prepared some topics here that are important to the refiner and bring them you to be a basis for questions. I hope you will all join in answering the estions since many of you are more familiar with the answers than we of the el.

Crude oil received from the mill by the refinery has quality value that can lessened in three main ways.

1. Free fatty acids that have developed by hydrolysis chiefly by enzymatic action.
2. Color that has been set by heat developed during exothermic fungal growth.
3. Color or loss potential developed due to manufacturing procedures.

The control of the free fatty acids is best handled by the care of the ds and their moisture content during harvesting and storage. Once the en-es have been produced by the growing organisms the prevention of their de-uctive action is very difficult.

[1]Director, Law and Company, Atlanta, Georgia 30301.

Color developed by heat cannot be reversed to the original compound that could have been refined from the product easily. Here again control of organisms is paramount. Heating during storage will raise the color as well as the free fatty acids.

During manufacture the development of free fatty acids cannot be avoided. Here again the enzymes present on the surface of the hulls and kernels are intimately mixed with the meats at the rolls and the action of the fat splitting enzymes is swift, requiring little time to raise the fatty acids.

There are precautions that can be taken to lessen the increase of color and bleach color. Color increase can be blamed on heat and time working hand in hand. A lot of heat for short time does as much damage as a little heat for a long time. Controlling the temperature and/or time is the key to low color oil. Heat and time factors are found in the cookers, expellers and in the case of solvent processing in the strippers.

Lubricating oil present in as little as 50 ppm causes the color and bleaching qualities of an oil to be degraded appreciable: 50 ppm is approximately 7.5# of mineral oil in a 150,000# car. The mineral oil that is being purchased for lubrication should be accounted for in its use. If a machine is using sufficient oil to equal a few ppm of the vegetable oil produced, it should be known that it does not find its way into the product.

Fully refined oil ready for shipment to the user is a product of high quality produced by know-how. It is our experience that the user of edible oils in many cases does not understand the technical qualities of fats and will attribute his product's off-condition to the fat used rather than the real causes. Off flavors due to fats are found mostly where the fats are misused during the manufacture of a product containing the fat. We feel that the education of this consumer to the qualities of our fats is an important step in selling of fats.

BACTERIAL CONTROL DURING PROCESSING OF COTTONSEED

By James J. Spadaro[1]

Cottonseed processors have become aware of the need for controlling bacteriological problems in their mills for two reasons: the development of a practical process for producing a high-protein cottonseed flour for human consumption that must be produced under sanitary conditions, and the increasing pressure for improving the quality of animal feeds. A study of bacterial contamination in three types of oil mills demonstrated wide variability in the number of different types of bacteria present in similar product samples in a particular mill and between different mills; high bacterial counts of starting materials; the kill-steps inherent in the processing operations; and occurrence of recontamination. Suggestions for microbiological control during processing include minimizing bacterial contamination of incoming cottonseed and cooling meals or cakes as they are conveyed from the desolventizer or screw press, insulating and sealing conveyors from the environment, periodically cleaning and disinfecting conveying systems, checking quality of air used in air conveyors, and relocating meal-handling systems if they are in a dusty area. Control after the kill-steps is particularly important.

Until about four years ago very little attention had been paid to microbial contamination in processing of cottonseed into oil and meal. Undoubtedly the reasons for the negligible interest in possible bacteriological problems were that (1) the oil was ultimately refined, bleached, and deodorized to produce an edible oil that was essentially sterile, and (2) the meal was used primarily for cattle feed. But by 1970 there was increasing interest in microbial contamination and its possible control. One reason, no doubt, was the progress that has been made in the development of a high-protein cottonseed flour for human consumption and this flour had to be produced under sanitary conditions. Another reason was the increasing pressure from FDA and other groups to minimize the incidence of salmonellae in animal feeds.

Some of you have heard of the study that had been conducted at SRRC to obtain a microbial "picture" in oil mills of the cottonseed products as they were processed from the fuzzy seed to the finished meal. I'd like to review this very briefly. Then I will discuss, in more detail, pertinent factors in the control or minimization of microbial contamination.

The initial source of contamination is the fuzzy seed entering the mill for processing. Table 1 shows the results of the analyses of 11 samples of seed for total plate count (TPC). Total plate counts were not only very high, but they also varied appreciably among different mills and within the same oil mill.

Likewise, other microflora such as molds, yeasts, *E. coli* and fecal coliforms in the fuzzy seed showed wide variations. For example yeast counts ranged from 0 to 200 per gram, molds from less than 10 to 100,000 and coliforms from 0 to greater than 2400. The fact that there were some low bacterial counts was encouraging. It indicated that perhaps seed with low levels of contamination could be obtained.

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Similarly, great variations in the number of these types of bacteria were found in the delintered seed, meats, flakes, and meal products.

In general the bacterial count of the delintered seed was lower than that of the fuzzy seed, however, in one case where there was no E. coli in the fuzzy seed, it was found in the delinted seed. Apparently the E. coli was picked up along the way in the transport system. Whole meats or coarse meats have somewhat lower bacterial counts than fine or mixed meats. This is important since whole and coarse meats are the fractions that will be used for production of edible flour. The final packaged meals invariably had appreciably higher bacterial counts than the cakes or meals as discharged from the screw press or desolventizer. Salmonella was not found in any of the fuzzy seed samples but was detected in two flake samples and two final meal samples.

Fortuitously, in each of the three types of cottonseed oil mills--screw press, prepress-solvent extraction, and direct solvent extraction, there is a kill-step that renders the meal essentially sterile. That is, the total plate counts of the meal as discharged from the cooker, screw press, or desolventizer were less than 4000 with the exception of one sample which was 15,000 (still considered low); all other bacteria counts were less than 10; and Salmonella was negative even though in two cases Salmonella was present in the flakes. Apparently the temperature and moisture conditions used in the cooking, screw pressing and desolventization operations are sufficient to render the resulting products essentially sterile.

Unfortunately, it appears that the mills may not take full advantage of these kill-steps. In practically all cases serious recontamination occurred apparently because of the method of handling of the meal from the time it was discharged from the press or desolventizer until it was bagged. Better sanitary conditions are needed for transporting, grinding, and other operations that take place before the meal is finally bagged. As an example of the degree of recontamination that can occur, in one case the discharged meal had a total plate count of only 3500, yeast and molds less than 10, and no coliforms or Salmonella. The final ground meal prior to bagging had a TPC of 450,000 to 7,000,000, yeast-20, molds-2000, fecal coliform-9, minimum probable number (MPN) coliforms--over 2400, and E. coli-9. One of four samples was positive for Salmonella.

A major problem appears to be the condensation of moisture from the hot meal in the transport system wherein dust and meal tend to agglomerate and set up ideal conditions for bacterial growth including that by Salmonella. These agglomerates tend to dry and sporadically break off and mix with the conveyed meal. This could also account for the large variations in results obtained.

To alleviate this problem it is suggested that: (1) the conveying system should be thoroughly cleaned and disinfected with a chlorine compound periodically; (2) the hot meal should be cooled immediately by means of a mixing conveyor with filtered circulating air; and (3) the conveyor should be insulated and sealed from the environment. If air conveying is used, the air should be checked for contamination. The meal handling system should be located in an area away from possible dust sources--particularly from dust generated by the raw materials, i.e., seed and hulls which tend to be very high in bacteria content. If hulls are added back to the meal to adjust protein content for animal feeds, the hulls should be heat treated.

Effort should be made to obtain "clean" seed and to minimize contamination during storage. Perhaps it is necessary to discuss cleanliness of seed with the ginners--to see that sweepings, etc., are not added to the seed; to cover

the seed while being transported in trucks; and to make efforts to keep birds and rodents away from the stored seed. This phase of minimizing contamination at the seed source will help in maintaining lower bacteria counts in subsequent processing steps. This is essential in mills that contemplate production of edible flour, whereby whole and cracked meats are used and where desolventization temperatures are kept at a minimum level to maintain high protein quality. With the lower temperatures, the desolventization kill-step may not be as effective as when higher temperatures are used.

There is a need for improvement in the overall sanitary practice in operations throughout the oil mill, particularly in the transport system.

TABLE 1.--Total plate count in fuzzy cottonseed, millions

Oil Mill	Samples[1]				Average
1	40.0	40.0	15.0	30.0	31.2
2	15.0	0.16	7.0	--	7.4
3	0.76	8.0	9.0	15.0	8.2

[1]Samples taken every hour for four consecutive hours.

APPROACHES TO LINTERS REMOVAL

By Carl M. Cater[1]

Figure 1 depicts the topic of this paper, "Approaches to Linters Removal On the right, we have undelintered cottonseed while on the left we have seed which have been saw-delintered to approximately 2 1/2 to 3 percent residual lint. Since I am neither an Engineer nor an Oil Mill Operator of many years experience, I am not going to presume to try to instruct those of you in the audience who fall into this category in the intricacies of linter operation and/or design. What I would like to do is to talk about some of the approache that are being taken to this process both from the standpoint of the tradition saw-linter as well as a number of other newer concepts which may or may not prove to be successful.

The delintering operation was introduced into oil milling many years ago as a means of producing another salable byproduct from the processing of cottor seed, in other words, for the purpose of increasing the amount of profit that could be derived from each ton of seed which was put through a mill. The same goal is still valid today. In looking at the linters market today we find that the current price of around 11 cents a pound is nearly double that at this time last year and about four times what it was in 1970. In fact, going back throug the years, we have to go all the way back to 1950 to find a year in which linters prices were as high as they are at present. The current high prices may lessen the interest of many people in exploring the alternatives to conventional methods of delintering, since linters today are a good profit item for the mill. However, if you will also look at the history of linters prices through the years, you will find that the average price has been much closer to 3 cents a pound than it has been to 10 cents a pound. We need to keep this in mind in considering future oil mill operations.

Figure 2 shows the linter room in one of the larger oil mills on the west coast. Lintering practices vary widely from mill to mill with some mills taking as many as 3 or 4 cuts of lint while others simply make mill-run. The method of operation must be adapted to suit the individual mill's needs and the markets at any given time. The biggest advantage that conventional saw-delintering has is the fact that we know how to do it. The method has been in use for many years, in fact, it is virtually unchanged from almost its first introduction. Machinery is installed and in use; we have the operating know-how; and it is always much easier to continue doing what you have been doing than it is to change. In addition, saw-delintering gives the highest return for the linters produced because these products have the highest value per pound.

Figure 3, for those of you who may not be familiar with linters, shows the working mechanism. The cover has been lifted and we see the float at the top and the saws protruding through the ribs of the gratefall. It is during the passage of the seed between the saws that the lint is cut from the seed. One of the disadvantages of saw-delinting, is the fact that it has a relatively large power requirement, not only for turning the saws, but also for the fans

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that are necessary for aspiration of the lint; for transport and for cleaning and baling. Another criticism of saw-delinters is that they are dangerous to employees because of the large number of belts and moving parts.

Figure 4 shows linters with individual drives fitted with safety guards. Figure 5 shows that these guards can be removed exposing the drive on the linter for necessary adjustments and repairs. Another major criticism of the conventional lint room is that it is a major contributor to air pollution. Figure 6 shows the linter room cyclones of a large California mill. Let me assure you that this mill is in operation and from on-the-spot observation, I could see no more dust coming from the cyclone exhausts than you can see in this slide. Unfortunately, not all mills are as well run as this. This points out another problem in running a conventional delintering operation, that is that it requires both skilled supervision and skilled labor to produce good products in an efficient manner. The lint room has a relatively large labor requirement and labor is becoming increasingly difficult to find both in terms of quantity and quality. When good supervision and good labor are lacking, you get results like those shown in the next two figures. In figure 7 it appears as though the termites have gotten to this linter and you can see where shielding is loose. Figure 8 shows that there are holes in the ends where dust and seed are leaking out contributing to the dusty environment within the lint room, as well as constituting a loss for the mill. Another of the problems with operating a conventional lint room is the necessity for continual sharpening and replacement of saws. Mills have many different arrangements for removing and transporting saws to the sharpening room. One such arrangement is shown in figure 9. This is a rather high risk operation and many injuries have been incurred in accomplishing it.

Moving to the outside of the mill another major problem is readily apparent, that of air pollution. This accumulation of lint and dust on outside structures and the roof, shown in figures 10 and 11, readily bear testimony to the emission of particulate matter into the atmosphere.

Another problem from the standpoint of OSHA is that of the noise generated by the high-speed saws of the linter and the brush and other attachments and equipment necessary for operating a conventional lint room. Technology has not yet been developed to reduce the noise levels in lint rooms to acceptable levels and presently the best alternative we may have is to simply limit the amount of time which an employee spends in this environment during his work period. Before concluding my consideration of conventional saw-delintering, I must point out that it has been over ten years now, since the first 18 inch diameter saw-delinter was tested by Carver in Arkansas. Since that time a number of these so-called "Big Linters" have been installed in mills in a number of locations. An approximate doubling in capacity is achieved by going to the larger diameter saw cylinder. This has several advantages such as reducing the number of machines required for a given volume of seed as well as a reduction in the lint flue system, conveyors, spouts, etc.

A concept which has been under development by two major oil milling companies for several years was just this past year licensed to Murray-Carver Company for manufacture and sale. This, of course, is the abrasive linter which is also referred to as the Buckeye or Acco Linter. This piece of equipment shown in figure 12 has several advantages when compared with the conventional saw linter. The labor requirement is lower than with saws because you do not have saws to sharpen. This piece of equipment will more nearly meet OSHA requirements because drives are simpler and guarding is less costly. Dust

emission control within the lint room seems to be better than with saw linte: The control of noise may also be easier because there will be fewer machines involved, since one abrasive linter can handle the capacity of approximately five conventional linters. Figure 13 shows a rear view of the linter showing the feed chute through which the seed enter the linter. Notice the plastic viewing window where the seed stream can be inspected. Figure 14 reveals a front view of the linter with it opened up. The rotor and front part of the linter which contains the abrasive bricks have been lowered and what can be seen here is the back part of the linter. Note the chute where the seed ente: the center of the linter. They then move outward to either end where they exi The lint is aspirated from the top on either side of the feed chute. Figure 1 shows an end-view of the rotor showing the steel bars which move the seed against the abrasive bricks. In figure 16 the grates in the bottom of the housing through which any hulled seed and other trash will fall can be seen. The slot on the end at which the seed exit is also visible. Notice the strip projecting from the side of the housing above this slot. There is an adjustin screw and the angle on which the strip projects out into the interior of the linter regulates the amount of seed which can exit through this slot. There is a matching slot at the other end.

Figure 17 illustrates one of the problems associated with the abrasive linter. Although it is cleaner in the lint room, it is dirtier on the outside because it produces a greater proportion of fine dust particles. Figure 18 shows the size distribution of dust particles from the abrasive and the saw linters. You can see the greater preponderance of smaller dust particles less than 15 microns in size is produced by the abrasive linter. Particles below 15 microns are not effectively removed from air streams by cyclones, and bag filters must be used. However, due to the fact that the abrasive linter is relatively free from any hazard of fires, it is feasible to use bag-house collectors to collect this fine dust. Therefore, this particular disadvantage can be overcome whereas saw linters are notorious for their fire-making capabilities which creates a considerable hazard in the use of bag-houses. This requirement for use of bag filters to remove the fine particle sizes could be said to be a disadvantage, however, since one of these pieces of equipment will replace five conventional linters, it will reduce the overall amount of air which must be filtered. Obviously installation of completely new equipment in a lint room, such as the abrasive linter, would require considerable investment. This piece of equipment is not used on first cut linters but rather for second and third cut, so it is possible that as old equipment deteriorates and must be replaced, the abrasive linter might be selected for the second and third cut function. There may be some loss of oil and protein in abrasive delintering due to hulling of seed and the quality of the linters is lower than saw-cut. I would like to point out that this piece of equipment is still in the process of development and modification and fine-tuning will probably continue for another year or more. However, it does appear to offer an additional alternative to those people who are considering the installation of new equipment in their lint rooms.

Another method of removing the linters from cottonseed which has been talked about for a number of years but, to date, has not been used by oil mills is that of acid-gas delintering. The cotton planting seed industry has used both wet and gaseous acid delintering on their planting seed for a number of years. This concept has several attractive features, the first of which is a considerably lower power requirement. This process would have very low labor

uirements and would not require the high degree of skill that is necessary a good saw linterman. Additionally it would appear that meeting of OSHA uirements for safety would not be too difficult. There is a question mark cerning the acceptability from the standpoint of EPA Standards since there a possibility of emission of ammonium chloride into the atmosphere. However, is felt that scrubbing devices can be utilized to eliminate this problem.

Plains Cooperative Mill in Lubbock, Texas, has just recently installed a ll continuous pilot plant unit to evaluate this process. As many of you w, most commercial planting seed acid-gas delintering operations are con- ted on a batch basis. Figure 19 shows the feed section of conveyor being ered into place by a forklift. This will take seed from the conveyor in the r and bring them out and dump them into the process conveyor in the fore- und. In Figure 20 the process conveyor in which the gaseous hydrochloric d (HCL) will be added for removal of the linters is shown. Figure 21 shows other end where the anhydrous ammonia is added to neutralize the HCl and seed are then dumped into a conveyor with a screen bottom. The screw of s conveyor will turn fairly rapidly and the seed will be rubbed over the een bottom to remove the lint. Please understand that this is a very sim- setup and a commercial installation would probably use a reel-type buffer accomplish this particular function.

The flow diagram in Figure 22 gives a better idea of the material flow. is not drawn to scale. Note that there are short sections where there is flighting on the conveyor screw to create plugs to prevent the loss of either eous HCl or anhydrous ammonia. These plugs are located at either end and in the middle to divide the two compartments. The seed are heated to 130 140 degrees F to maximize the effect of the gaseous HCl. Charlie Hay of the ns Co-op, indicated that he had initially thought they would be able to also minate the seed cleaning operation. He has now changed his mind because the ence of dirt and trash in the seed increased the amount of acid that was essary and also sticks and rocks caused problems in the hullers and separa- . As many of you know we are engaged in research at Texas A&M on a contract the Southern Regional Research Center here in New Orleans for the investi- on of delintering processes for cottonseed. The acid-gas procedure is one he possibilities we are charged with investigating and we hope to have tional information to report on this in the future. The primary potential dvantage of acid-gas delinting is the fact that the linters produced may be able to be utilized for the traditional linters market if their polymeric has been degraded below the size necessary for conventional uses. In addi- clearance must be obtained before hulls from seed treated in this manner be sold in interstate commerce. However, in view of the fact that ammonium ride has been approved as a feed additive for certain purposes, little iculty should be anticipated in this particular area.

Another possible alternative to conventional delintering is that of dehull- undelinted seed or seed with 7 percent or more residual lint. Some of the ntages of this would be that all or most of the cost associated with delint- g would be eliminated as well as the problems involved with labor, OSHA and It would also be possible to produce a high-protein low-fiber meal which d be moved into specialty markets if so desired. We have demonstrated the bility of this particular procedure in our pilot plant in the Oilseed ucts Division at Texas A&M. The disadvantages to such a process would be the returns from the linters would be reduced to the price of the cotton- hulls and also that losses of oil and protein in the hulls would be

considerably greater than for saw or acid-gas delinting. These losses might run as high as from 1 to 3 percent of the total oil and protein in the seed.

Still another alternative is the cold pressing of whole undelintered cottonseed. Some of you in the audience are aware that the J. D. Hudgins Ranch in Hungerford, Texas, and others in the past have cold-pressed whole cottonseed and used the resulting press-cake as a very satisfactory feed. The other alternative to this is to condition the seed and then put them through the expeller and Mr. John V. Stiles of the Taylor Cotton Oil Mill in Taylor, Texas, has done this for a period of time this year. The analysis of his press-cake indicates a residual oil content of 7.2 percent. The nitrogen content is 4 percent for a value of 25 percent protein and a crude fiber content of 29.5 percent. The advantages of this process are that it eliminates seed cleaning, delintering, hulling, separation and also the bale pressroom. This greatly reduces labor and power requirements and also eliminates a large part of the pollution and occupational safety problems. There are some disadvantages, of course, and that is that the product must be sold to the ruminant feed trade because of the high fiber content. It may be necessary to sell direct to feeders until the identity of the product has been established with the feed industry. Residual oil at about 7 percent is fairly high and, of course, the through-put of the expellers is reduced. However, this may be a viable alternative for small independent mills that cannot afford to update their lint rooms in terms of conversion from line-shaft linters to individual drives and the installation of high efficiency cyclones or bag-houses or whatever might be necessary for them to comply with the air pollution standards. As an additional alternative to this procedure, it should be possible to solvent extract the presscake to reduce the residual oil to a lower level. However, the throughput of the extractor would be reduced and it may be difficult to desolventize this product thus increasing the solvent loss and cost. Also, larger volumes of solvent may be required for the extraction of this material.

The last alternative to conventional delintering which I would like to mention today is that of the use of enzymes to degrade the linters so that they can be removed from the seed. It is known that when cotton fibers are brought into contact with specific cellulolytic enzymes, the enzymes act on the fibers only in certain spots or sections. Although linters are different in nature from the cotton fiber, it is possible that enzymes will attack the weakest section of the linter which is believed to be the point of attachment of the linter to the seed. If this is correct then enzymatic delintering may be possible. The enzyme action may weaken the attachment of the linters to the seed sufficiently that light rubbing or brushing will remove them and thus eliminate the necessity for violent mechanical force. This would also eliminate a large proportion of the currently necessary dust control equipment. A major restraint to enzymatic delintering is that the enzymes must be in an aqueous environment to act upon cellulose. This has some very obvious disadvantages if the seed must remain in this environment long enough for water to be imbibed into the seed and activate enzyme systems within the seed itself. This could lead to activation of lipolytic enzymes which would degrade the oil and lower its quality as well as the possibility of a similar effect on the protein. The success of this method will be dependent upon the availability of enzymes which function with sufficient rapidity to reduce the high moisture phase of this process to a period of certainly less than one hour.

This concludes my presentation of approaches to linters removal and I will close by saying that there is probably no universal solution to linters

removal which will be equally applicable to all mills. Each mill is going to have to consider their own situation in terms of availability of labor and its cost, equipment, OSHA and EPA considerations and certainly the linters market. They must then determine what method of operation is best suited to their individual situation.

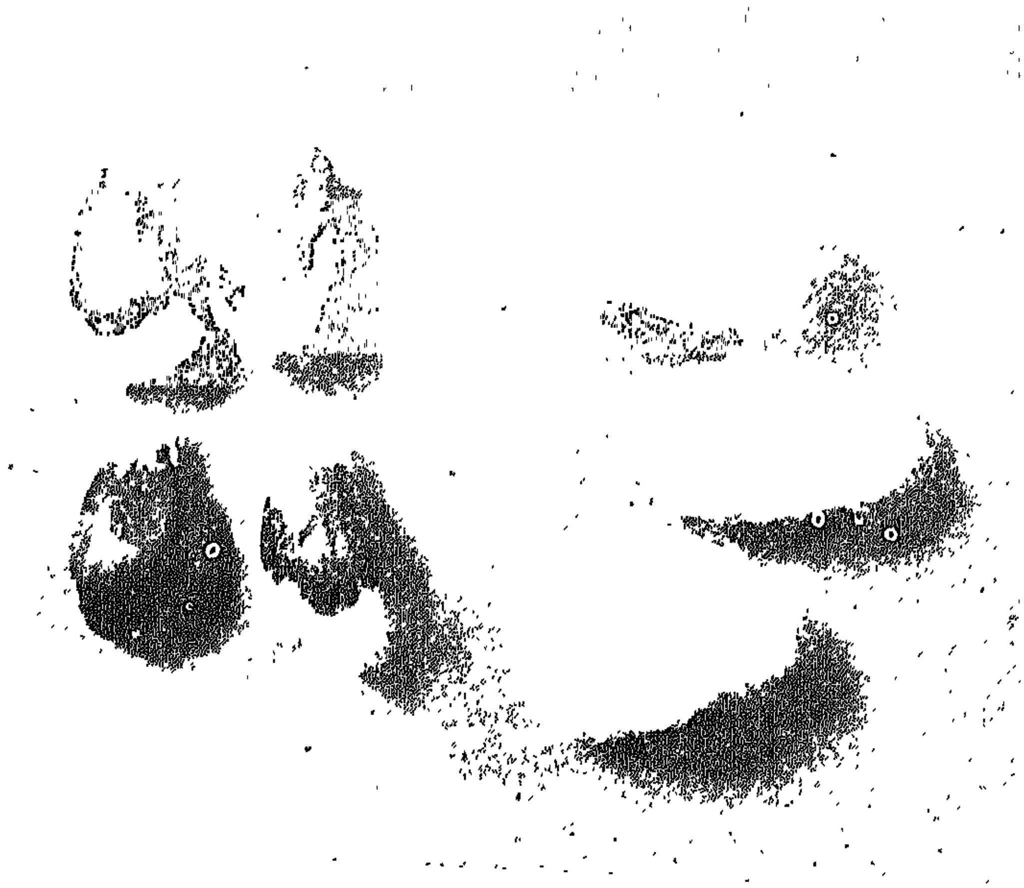

Figure 1.—Undelintered (right) and delintered (left) cottonseed.

Figure 2.--Linter room in an oil mill.

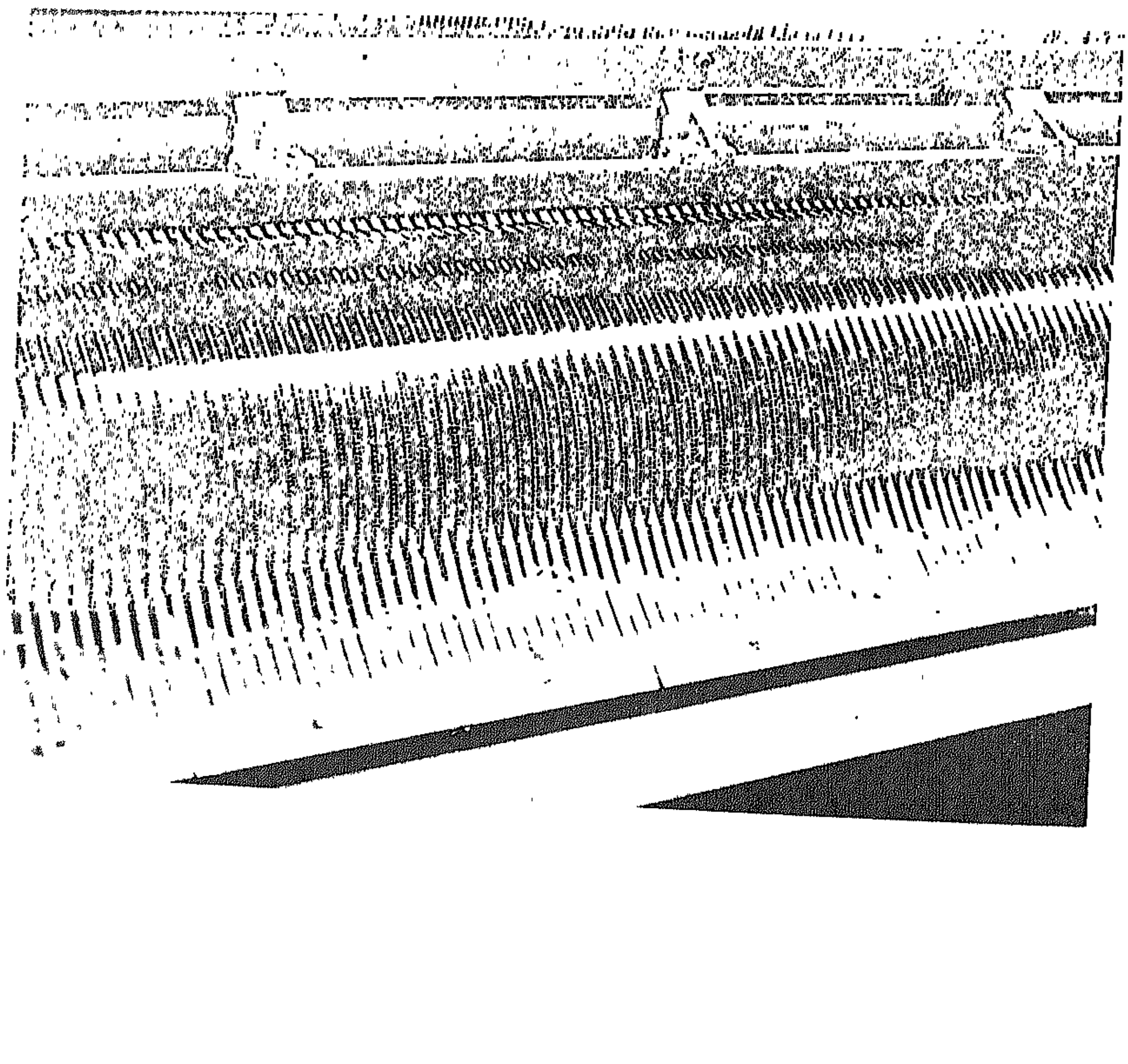

Figure 3.—Working mechanism of a linter.

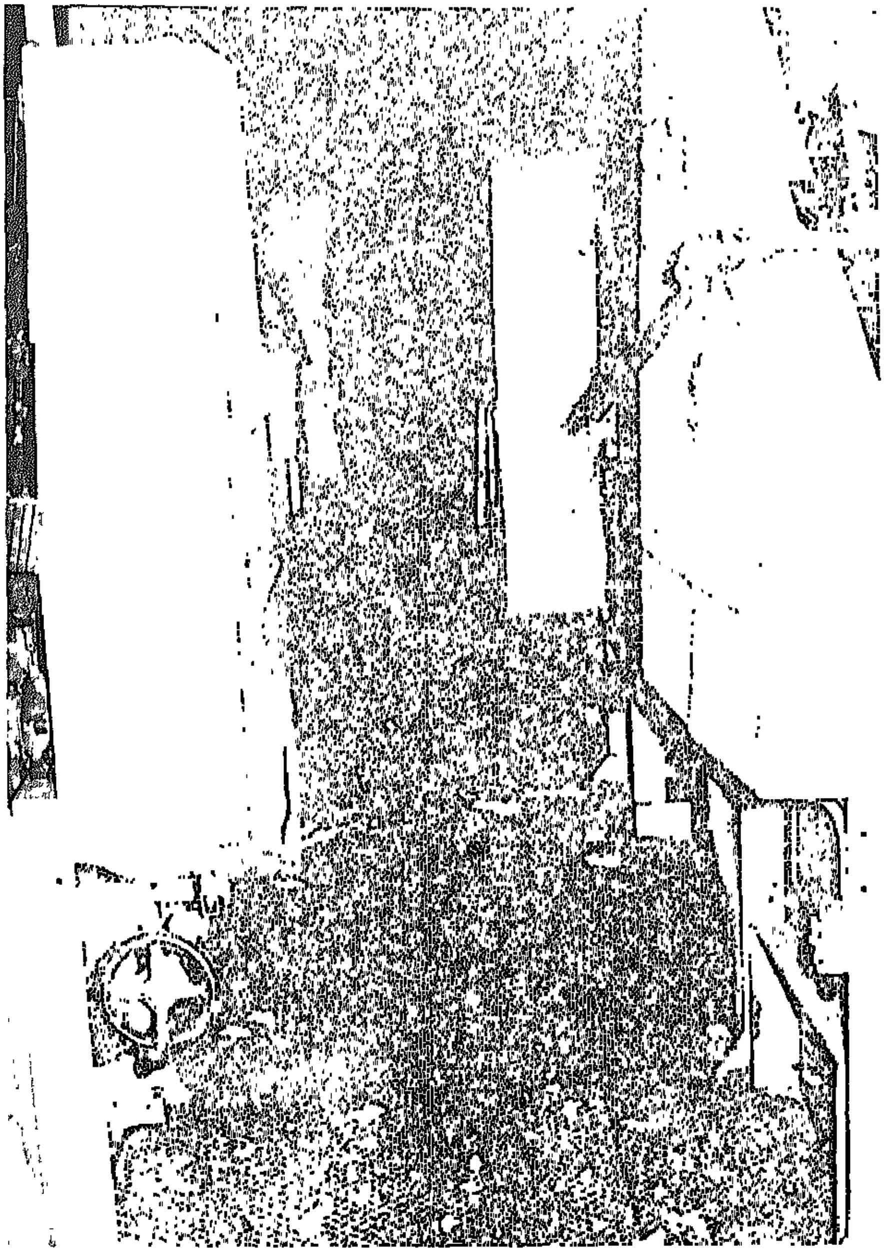

Figure 4.--Linters with individual drives fitted with safety guards.

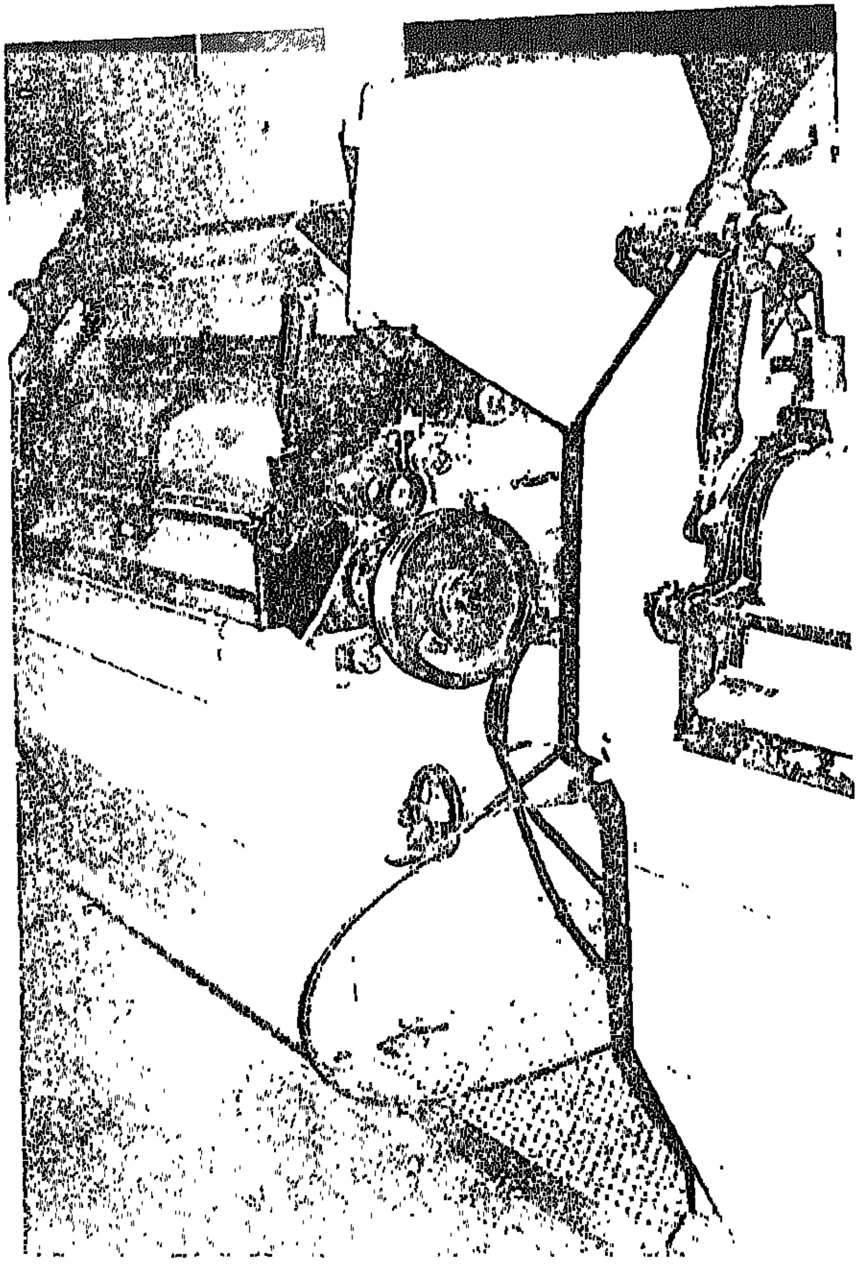

Figure 5.--Linter with guard removed from drive.

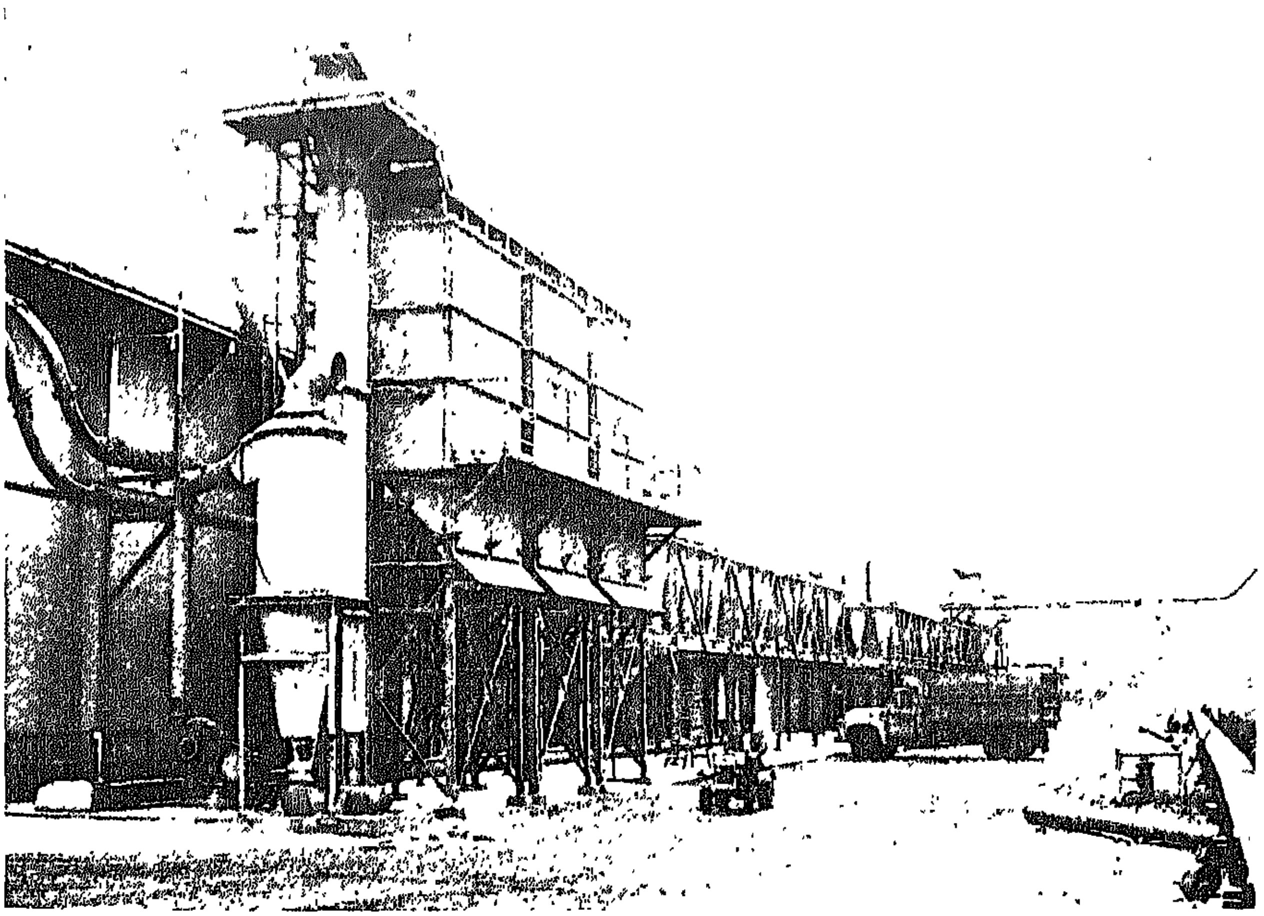

Figure 6.--Linter room cyclones.

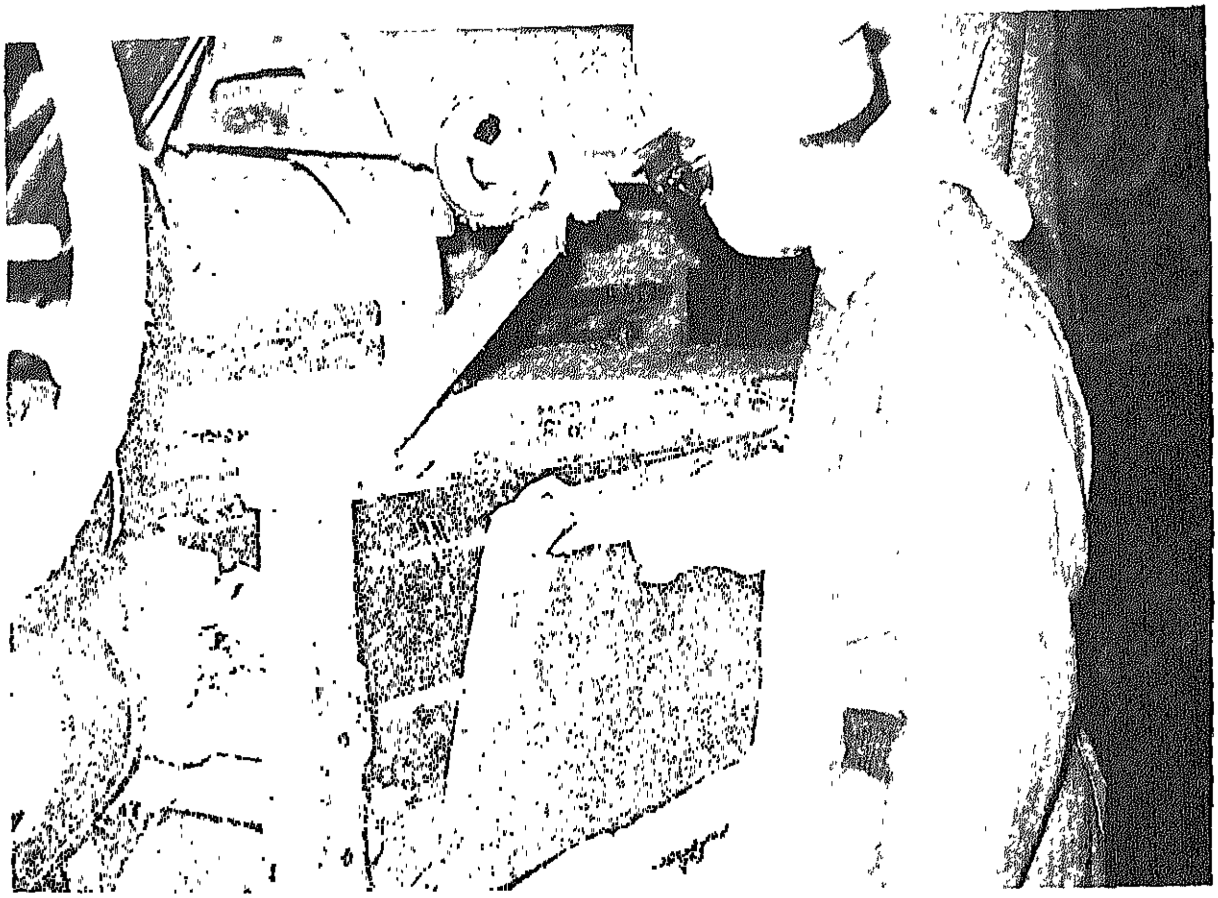

Figure 7.—Termite damage and loose shielding on linter.

Figure 8.—Leakage of dust and seed from linter.

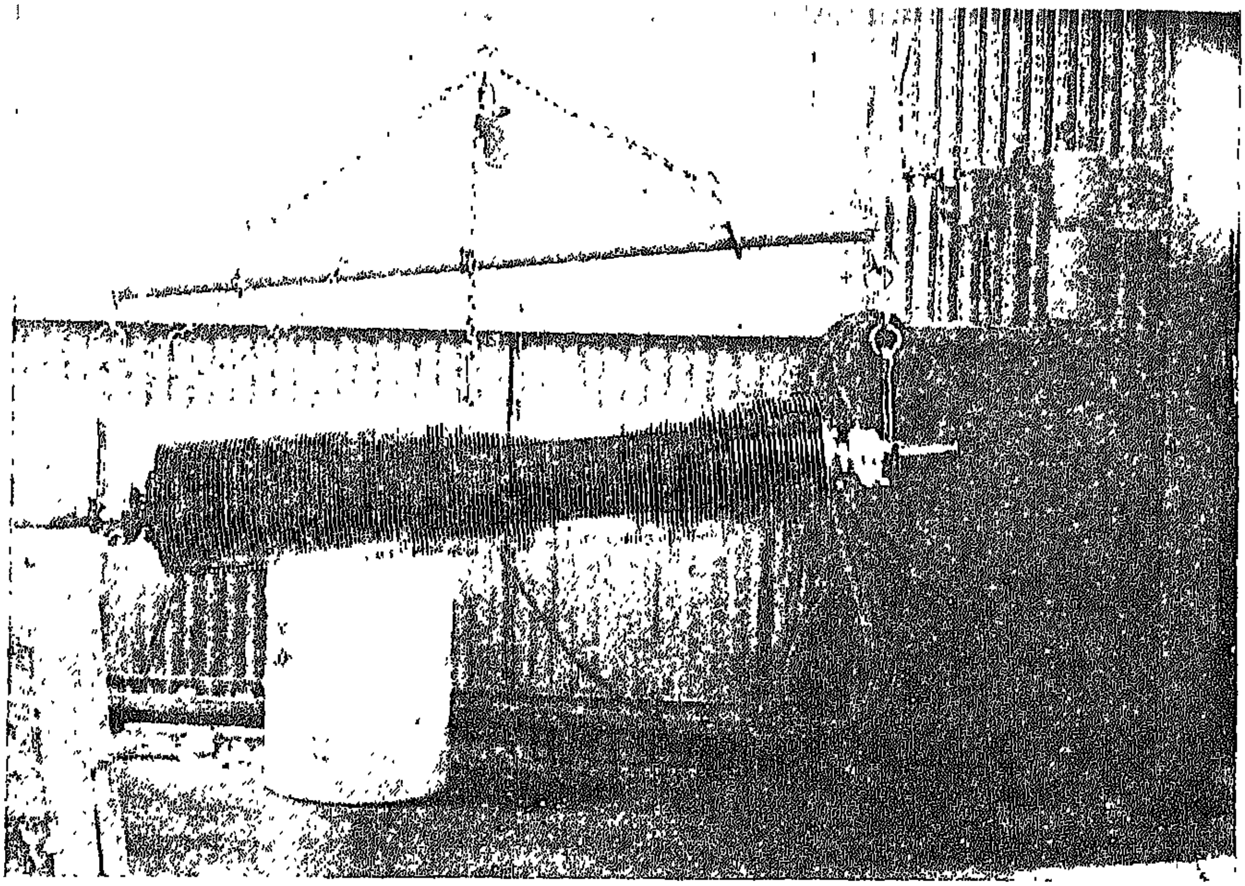

Figure 9.--Dangerous arrangement for removing and transporting saws to sharpening room.

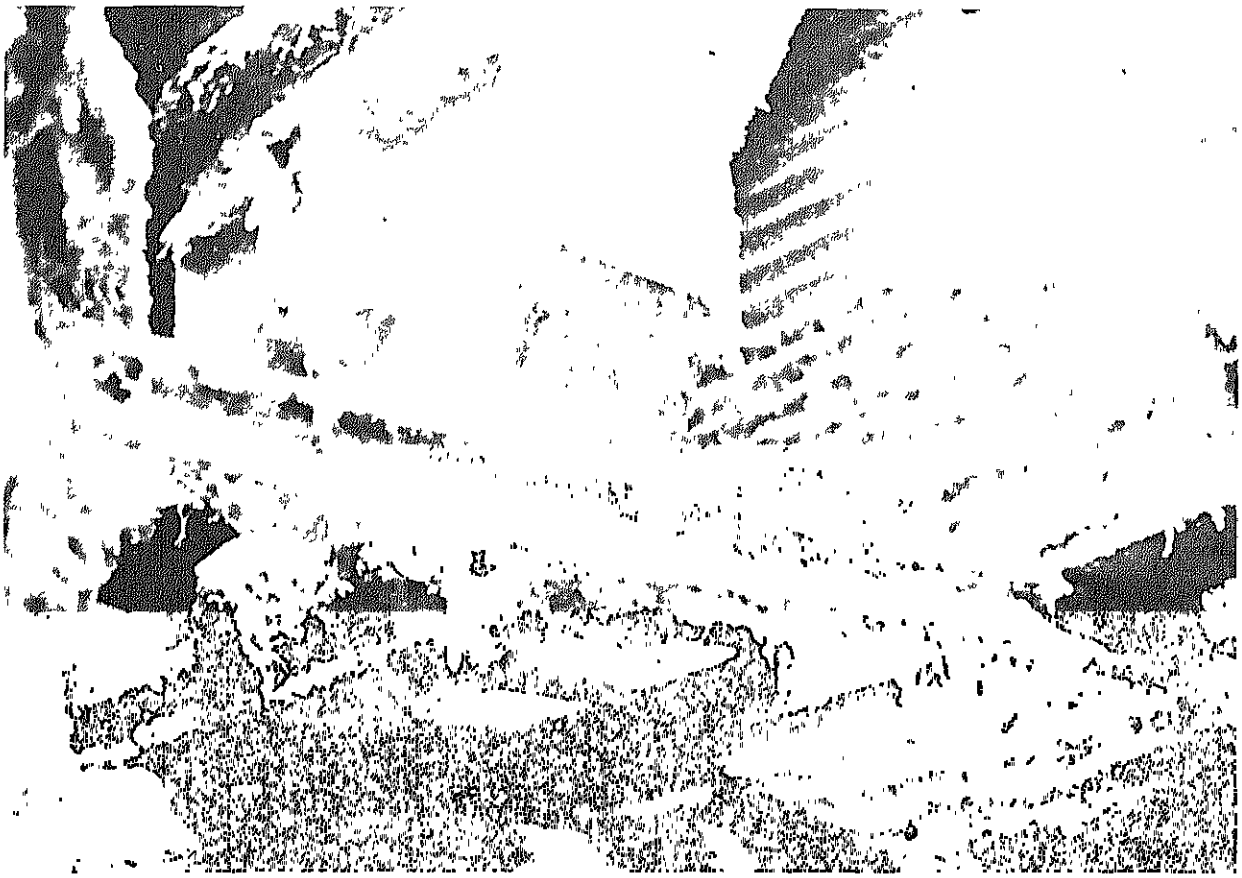

Figure 10.--Accumulation of lint and dust on outside structures of mill.

Figure 11.--Accumulation of lint and dust on roof.

Figure 12.--Abrasive linter.

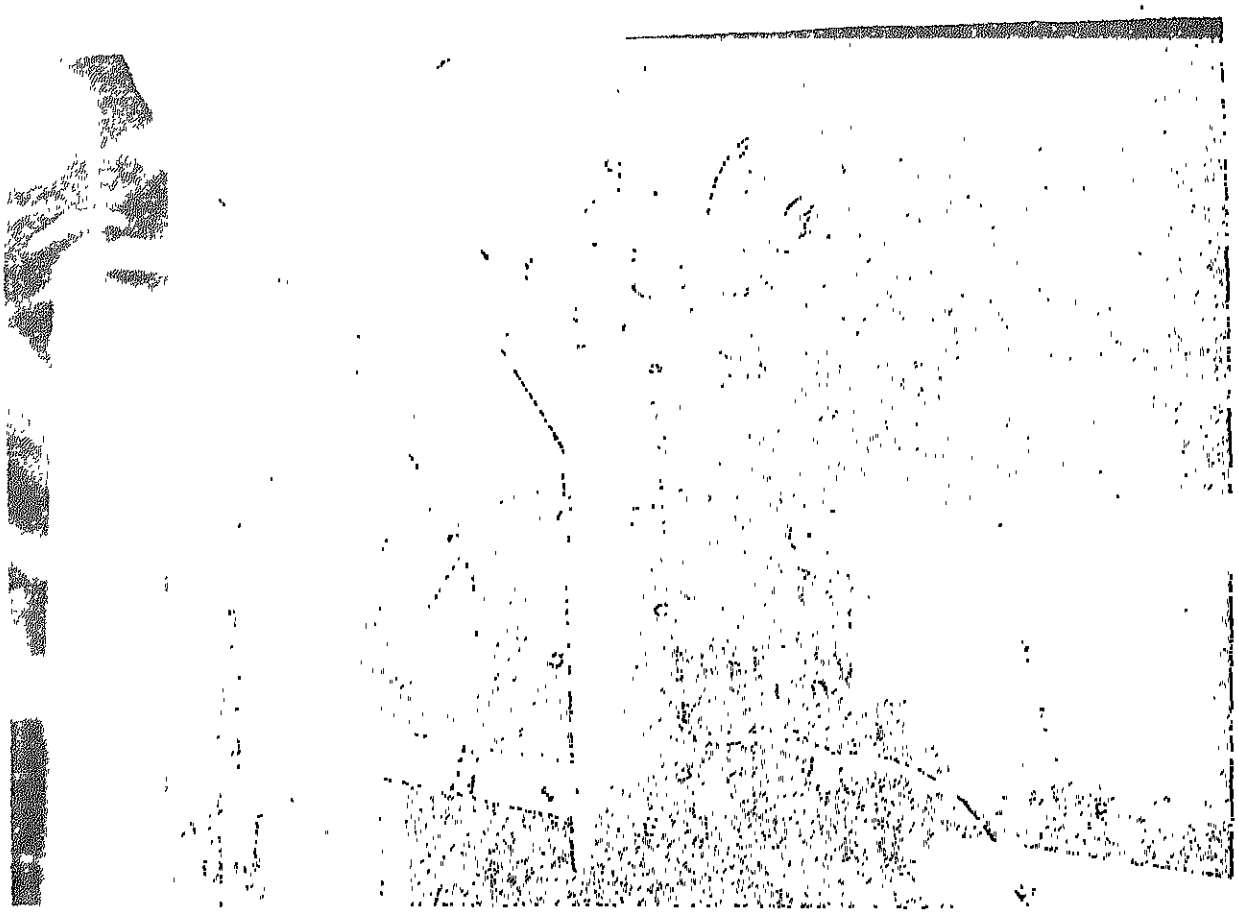

Figure 13.--Rear view of abrasive linter.

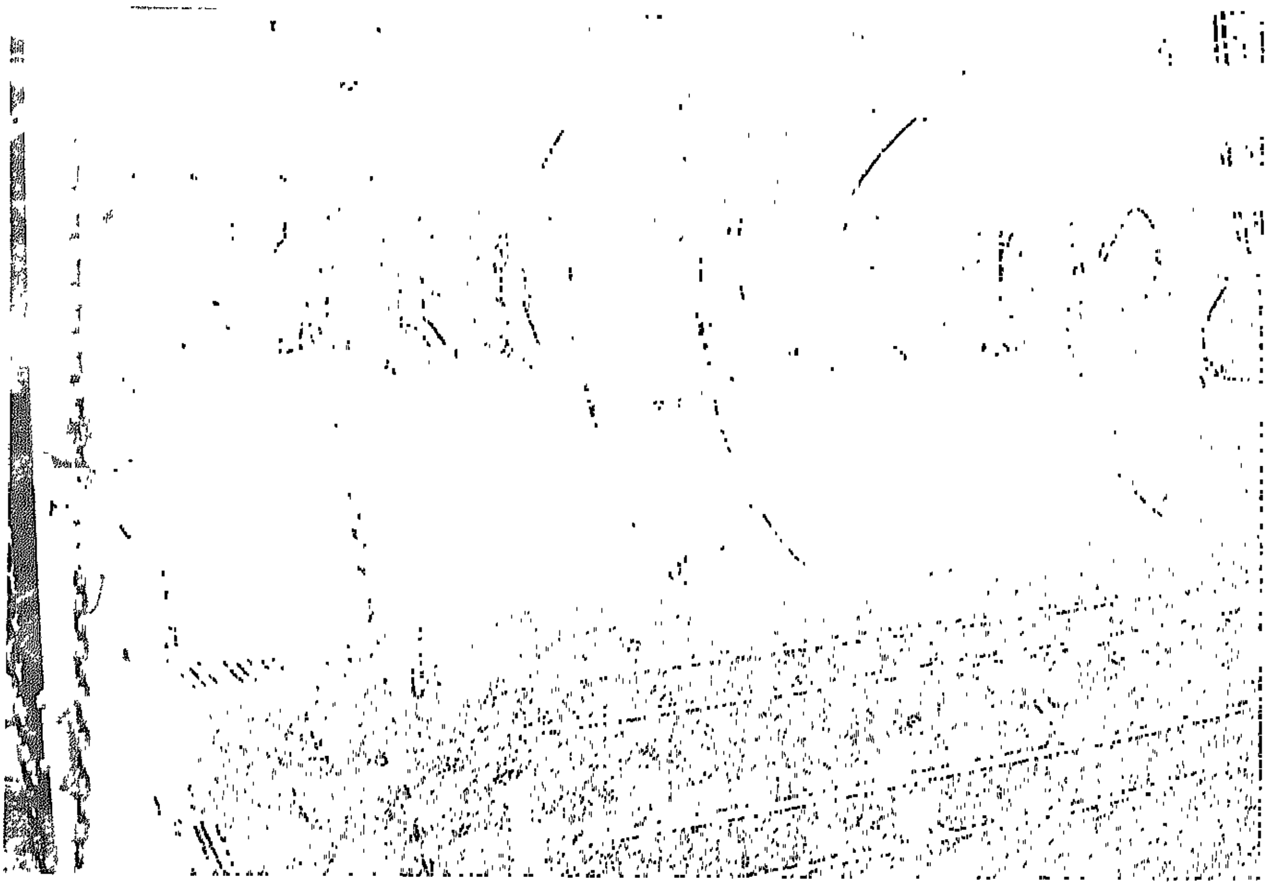

Figure 14.—Front view of abrasive linter.

Figure 15.--End view of rotor of abrasive linter.

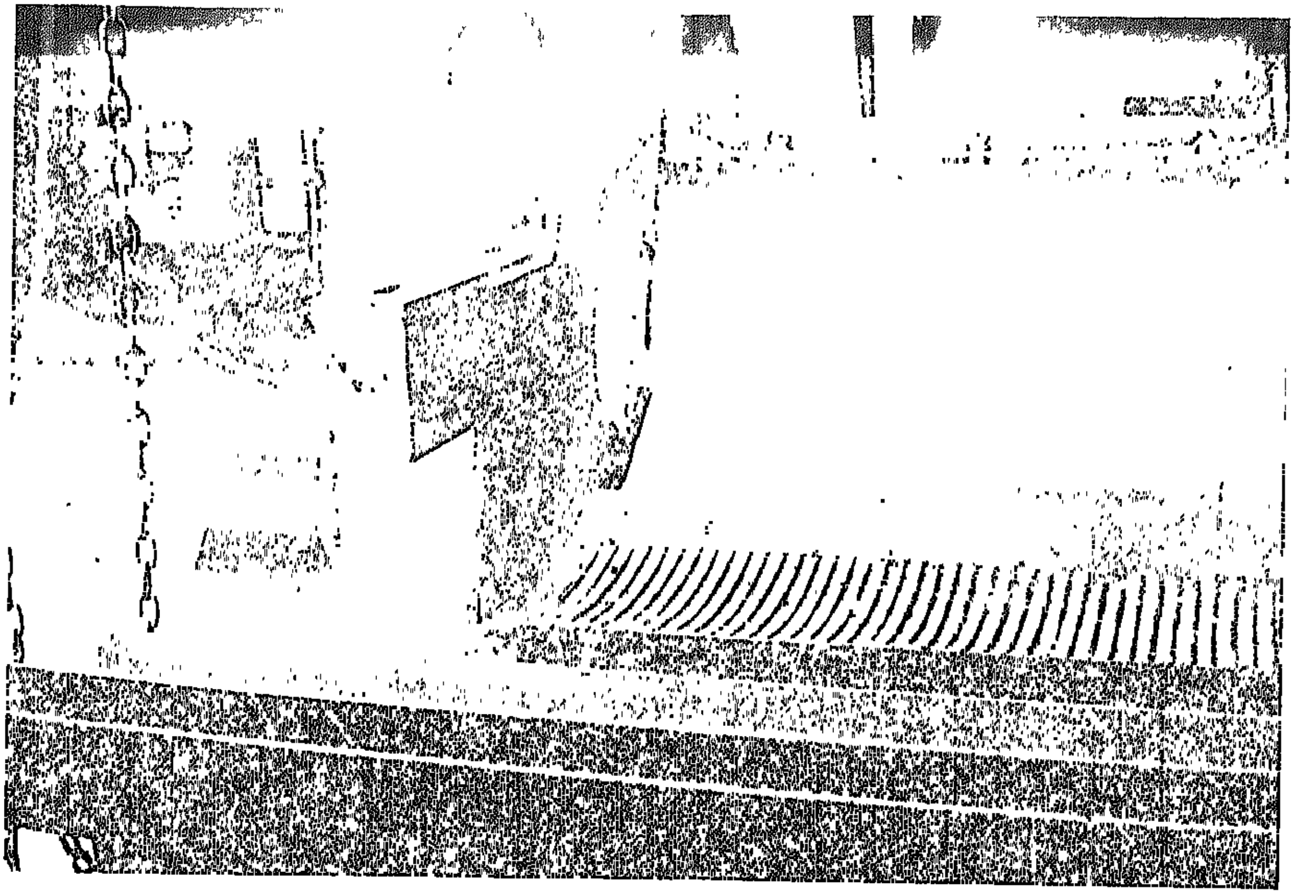

Figure 16.—Grates in bottom of housing of abrasive linter.

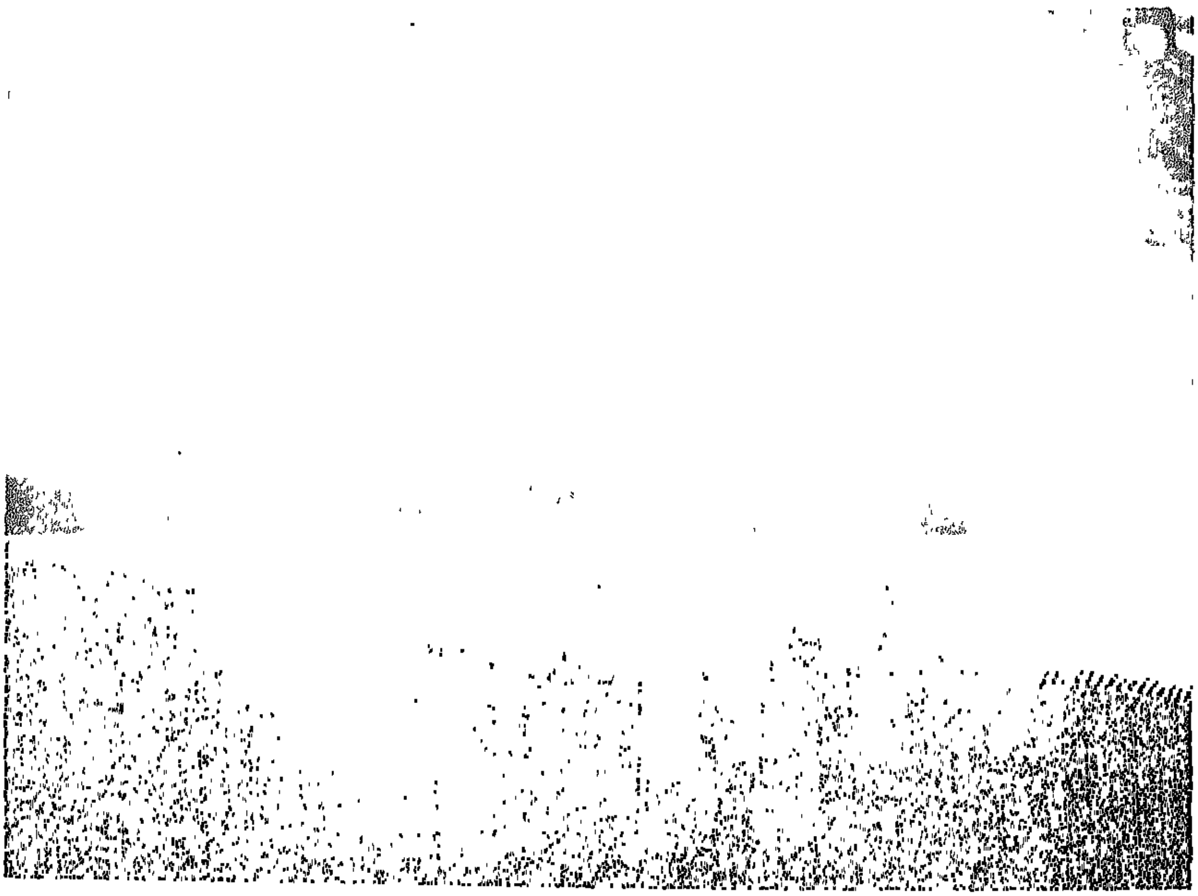

Figure 17.--Exterior view of abrasive linter showing dust particles.

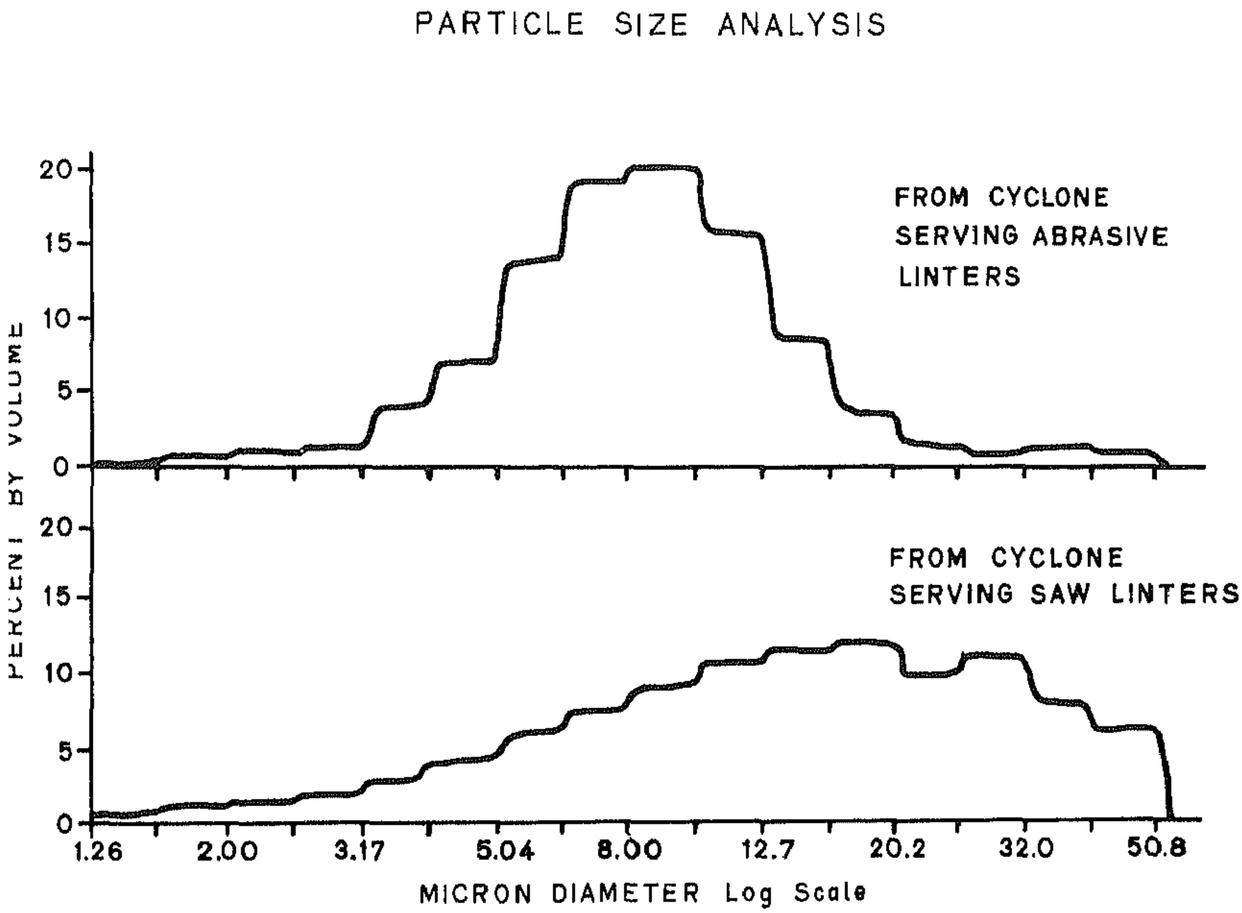

Figure 18.—Size distribution of dust particles from abrasive and saw linters.

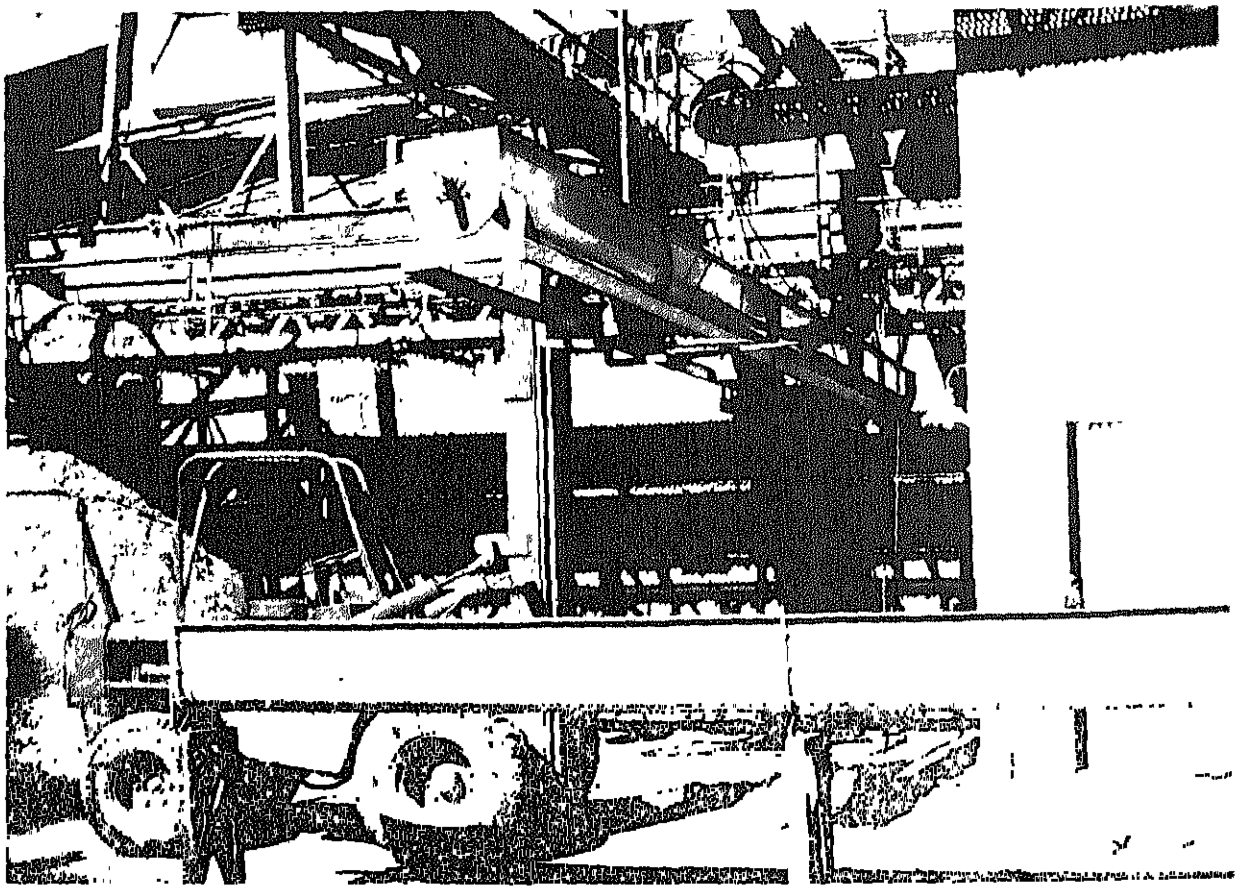

Figure 19.--Feed section of conveyor being lowered into place by a forklift.

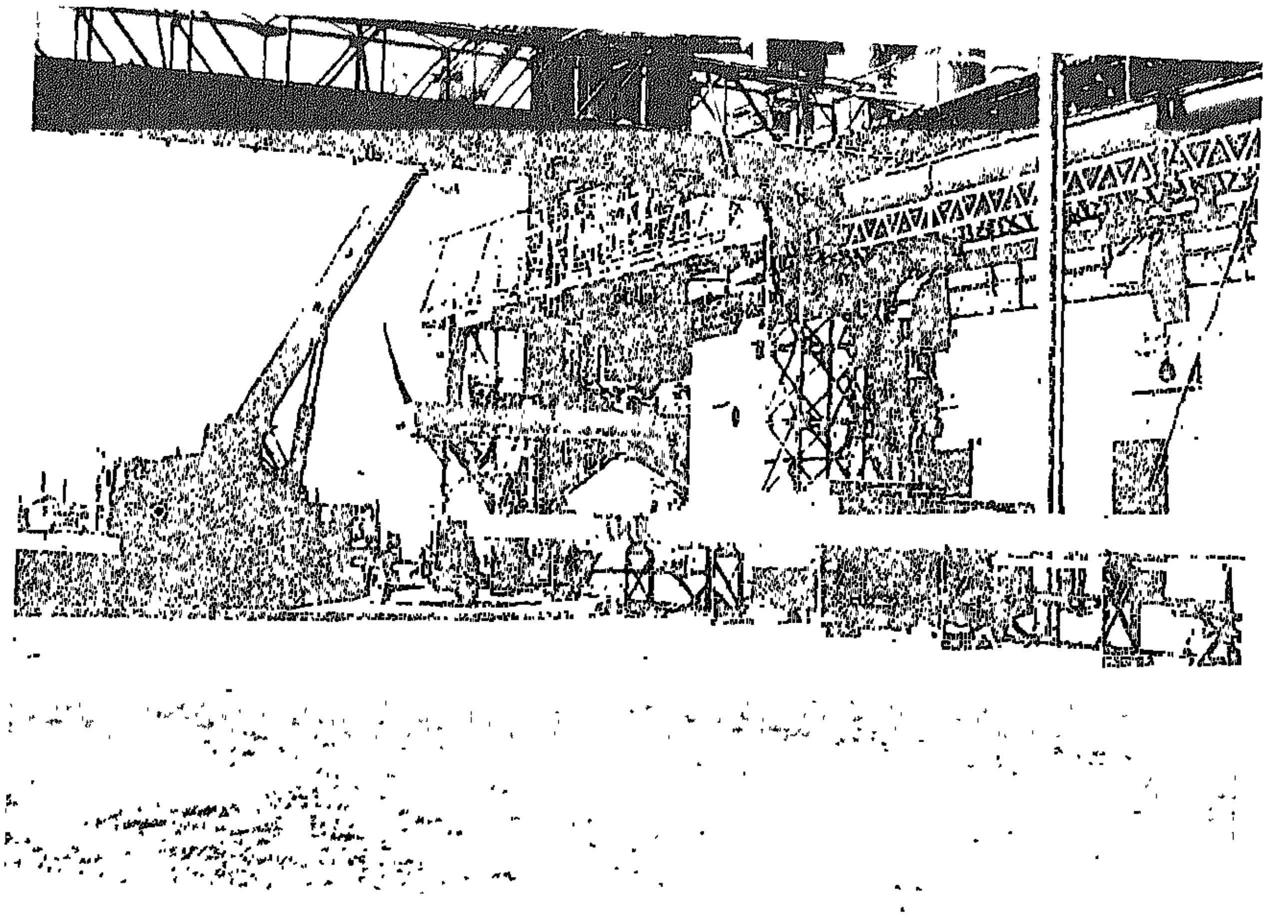

Figure 20.--Process conveyor where gaseous hydrochloric acid is added to remove linters.

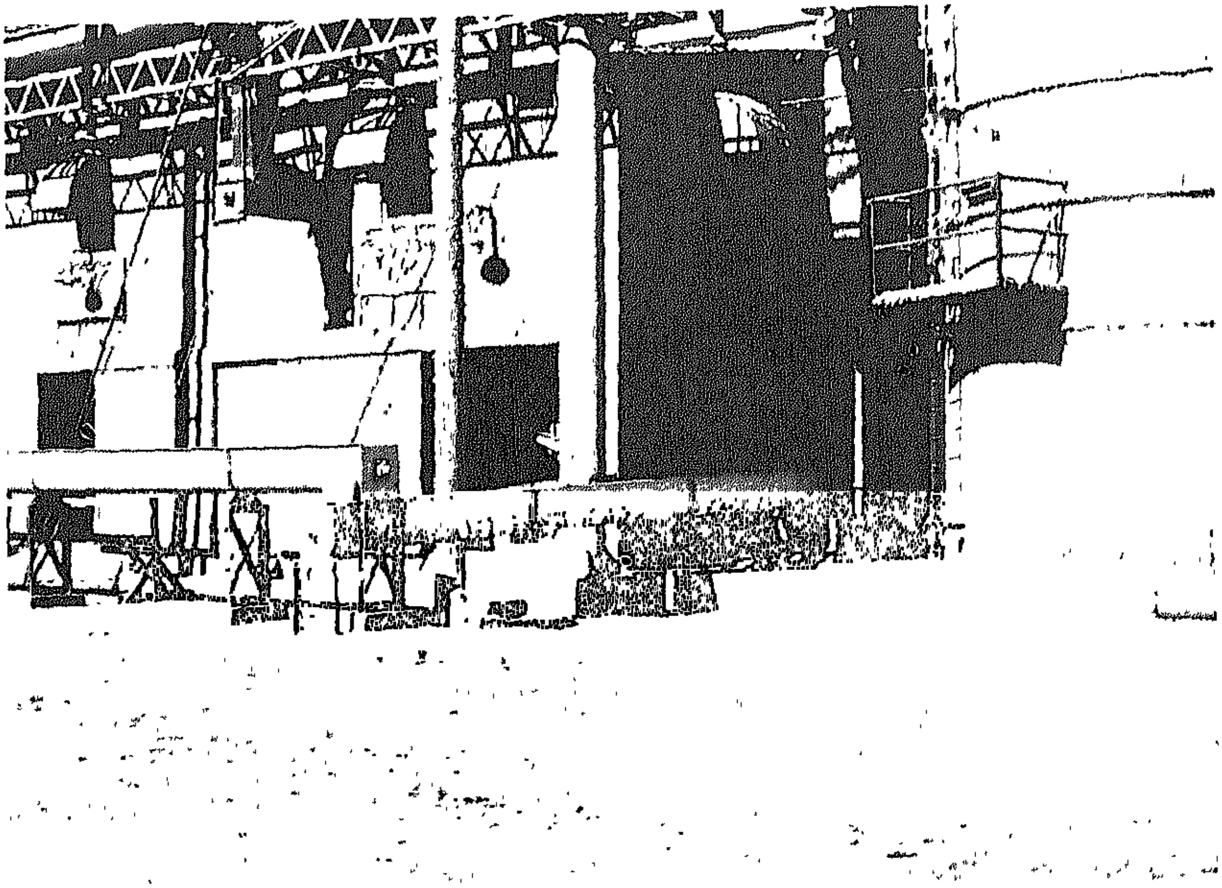

Figure 21.—End of process conveyor where hydrochloric acid is neutralized.

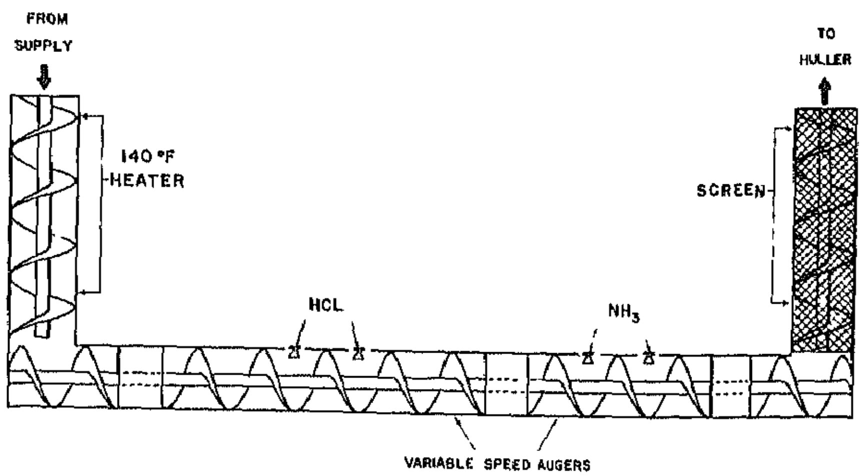

Figure 22.--Flow diagram of small scale continuous acid gas delintering.

OUTLOOK FOR U.S. OILSEED PRODUCTS

By Raymond E. Beacham[1]

Before we make an attempt at analyzing the outlook for U.S. oilseeds, let's take a look at some of the changes that have taken place in American agriculture and the changes that have taken place in the world demand for agricultural commodities in general.

For many years, agriculture in the U.S. has operated somewhat in the absence of a free market system. In the past, the government has provided various farm programs in an attempt to keep grain supplies more or less in balance with demand. These programs have generally been a combination of acreage controls and loan programs. In years when production outpaced demand and prices became very depressed, the government took over the grain under loan and attempted to devise a farm program for the next year which would encourage farmers to reduce their acreage of surplus grains. Then, as production of grain did not keep pace with demand and as prices strengthened, the government began to release inventories to the market and to prepare a farm program for the next year which would encourage expansion of the crops in short supply.

Prior to the upsurge in demand for U.S. grains in 1972-73, there were large increases in government farm programs and the government had accumulated stocks of grains. In 1972 there were 63 million acres of land under government programs. In 1973 this was reduced to 20 million acres. For the upcoming crop year, all set-aside acreage has been freed for crop production. In 1970 the Commodity Credit Corporation owned 955 million bushels of grain. Since that time this quantity has been liquidated, except for a small amount of oats.

One requirement of agriculture as a growth industry is expanding markets—this expansion needs to be realized not only in existing traditional markets, but also in new areas of the world. We saw new market areas developing last year with the occurrence of U.S. grain purchases by Russia and China. To what extent these markets will remain with us in the future is difficult to determine. Due to these expanded markets and the increase in U.S. agricultural exports, we have eliminated practically all government grain inventories and freed-up all of the productive land in the U.S. to grow the crops which are dictated by market demand and prices. In other words, the farmer now has the freedom to plant his land to the crop of his choice, and this choice will depend to a great extent on the market prices of the various commodities.

What brought about the upsurge in demand for U.S. agricultural commodities last year and this year? First of all, there has been a shift in consumer diets in other parts of the world—a trend toward more meat and less carbohydrates in the diet. Coupled with this change in demand was the crop failure in various parts of the world. Also, the absence of Peruvian fish meal in world markets created more demand for U.S. soybeans and soybean meal. Is this increased demand for U.S. agricultural commodities here to stay? We at Cook feel that it is. To better understand some of the changes in world demand, we must consider what is taking place in certain countries and regions of the world.

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[1]Oilseed Processing and Refining Division, Cook Industries, Inc., Memphis, Tenn. 38101.

The Russians need feed grains and protein to produce meat for their people. Long-term, they do not need wheat. The only reason they bought large quantities of wheat last year was to prevent a reduction in their livestock numbers, which was initially caused by their crop failure. The Russians have had many crop failures in the past 20 years. However, in those years they simply reduced their livestock population and fed the people less. This time they actually imported every pound of grain that was lost in their crop failure. They did not slaughter their livestock, in fact, they continued to expand livestock numbers. In this case, the Russians decided to feed the people and not to slaughter the livestock and they had to import large quantities of grain to meet these requirements.

Transitions of this type must be kept in mind whenever crop failures occur in Eastern Europe and in some other areas of the world. These governments are making decisions; they are not going to let their people go hungry. A government risks losing power by not satisfying the needs of its people. We have seen North Africa and Algeria buy hugh quantities of wheat when they were expecting a crop failure. We have seen the Egyptians buy tremendous quantities of wheat because they want to improve the diets of their people. We have seen changes taking place in most Eastern European countries. Poland is increasing livestock production at a rapid pace. This will mean even more feed grain and protein demand for the livestock industry.

The only countries in the world that have not been large consumers of U.S. grains are Pakistan, India, and Bangladesh. These countries have 700 to 800 million people and yet their grain consumption is less than most of the rest of the world combined, excluding China. These countries offer a great deal of potential for U.S. commodities. They have had crop failures and they do not have an adequate fertilizer supply this year. We feel that the direction of activity in Pakistan, India, and Bangladesh will have a major impact on all of the commodity markets in the near future.

The income levels of the Japanese are increasing and they are demanding more meat than can be supplied. This indicates an increasing demand for feed grains and protein in Japan. In addition, we expect to see substantial increases in the demand for feed grains and protein in some other countries, such as Taiwan, who plan to export meat to Japan. It has been thought that per capita meat consumption in Western Europe was reaching a peak. However, if we realize that per capita consumption in Western Europe is less than one-half that of the U.S., we can see there is still much potential for growth. One key factor we must remember is in converting from a vegetable or grain diet to a meat diet, it takes approximately 8 pounds of grain to produce 1 pound of meat. When this conversion takes place, the demand for grain is increased substantially.

China, by far, will be the largest consumer of U.S. agricultural commodities this year. This country will probably import close to 1 billion dollars worth from the U.S. Will China continue to be a large, long-term importer of U.S. agricultural commodities? They will probably continue to import large quantities of wheat from the U.S. They will probably also continue to import cotton. We feel that their decision to import cotton is strictly political. They view the U.S. market as a potential outlet for their products. The Chinese have always traded with the Canadians and the Australians, but the combined population of these two countries is only 40 million. China has an unlimited supply of labor; they can produce products very cheaply--and the U.S. is the potential market place for selling this labor. The Chinese are looking

at the very long-term advantage of establishing a trading relationship with the U.S.

Thus far, we have dealt strictly with the overall world demand for agricultural products. Although we have not specifically discussed oilseed products, the overall situation that we have outlined here will have its impact on the oilseed complex.

We expect continued growth in the demand for U.S. protein. Animal numbers in the U.S. over the next several years should expand and thus create more demand in the U.S. As we explained in our previous comments, there is a change taking place in various parts of the world--a trend toward more meat in diets. This will provide for a continued growth in the world demand for protein. As these countries move toward a livestock economy, we believe there will be a shift to more efficient feeding practices and this will, in effect, compound the demand for protein.

Total world trade of fats and oils is growing at an annual rate of 350 thousand tons per year. We feel that this type of growth, along with the extreme deficiencies of fats and oils in India, Pakistan, and Bangladesh, will result in a continued strong demand for U.S. vegetable oils.

We feel that the main competition in the world for U.S. oilseed products in the future will come from Brazilian soybeans and products, Peruvian fishmeal and Malaysian palm oil. There is not much room for production expansion in other parts of the world due to restricted land availabilities, erratic climatic conditions and limited technology. Brazilian soybean production is expected to continue increasing at a rate of about 1 million tons per year. For the next several years, Malaysian palm oil supplies should increase at a rate of 100 to 150 thousand tons per year. Peruvian fishmeal supplies will continue to fluctuate from year to year, but we do not anticipate that they will ever again reach the high levels that we have seen in the past.

The carryover of soybeans in the U.S. this year is projected at 200 million bushels. The 1974 soybean crop is currently projected at 1,550 million bushels. With the current price relationships between soybeans, cotton and corn, it is highly possible to see a further shift from soybean acreage to cotton and corn. The availability of fertilizer will directly influence the magnitude of this shift. The size of the 1974 soybean crop will not only depend on the final acreage planted, but also on the yields obtained.

A projected carryover of 2.7 to 3.0 million bales of cotton this year makes it difficult to see a supply next year of more than 16 or 17 million bales. With the world demand for cotton, we expect to maintain a relatively small carryout for several years. This should provide the U.S. producer with the incentive to continue producing cotton near this years's level--thus resulting in a cottonseed supply of about 5.5 to 6.0 million tons.

How is the U.S. going to meet the growing world demand, not only for oilseed products, but for all grains? In the past, when large increases in the demand for a commodity have occurred, we simply planted a larger acreage to that commodity. We can see an example of this if we look at the mid-1960's when there was a large increase in the demand for corn, wheat, and soybeans. The south shifted hundreds of thousands of acres from cotton and rice to soybeans. The west shifted from corn to soybeans and from oats to soybeans. As a result, we over-produced the soybean demand in about two years, and at the same time we over-produced the wheat demand. However, the situation as it was then is not the same as that of today. This year we have record prices on soybeans, wheat, cotton, corn, rice, and sugar beets--and we have a shortage

of every commodity in the world. Because of this shortage of every agricultural commodity in the U.S. and in the world, we are not going to over-produce any commodity very rapidly. With the shifts expected this year from soybean acreage to other crops, it is very likely that by September 1975, we will have soybean inventories back to a bare minimum again. With this in mind, one cannot afford to be very bearish soybeans and oilseed products for the next eighteen months.

In three years we may begin to solve the supply-demand situation in most of the basic commodities. It is possible that we will be even longer in solving the problem. Suppose countries such as India, Pakistan, and Bangladesh--who are in such great need of food items--find the money to buy the commodities they need? All crop land in the U.S. is, for the most part, committed. The same is true in most of the other areas of the world. Therefore, new land must be cleared, or we must have a breakthrough in yields to meet the increasing demand in the world.

COTTONSEED: PROGRESS OF RESEARCH
AT TEXAS A&M UNIVERSITY

By Karl F. Mattil[1]

The Food Protein Research and Development Center at Texas A&M University has a commitment to the Natural Fibers and Food Protein Committee of Texas to assist in any way that we can to improve the markets and marketability of cottonseed. For the past five years, our attention has been focused upon the market opportunities in the food industry.

One can make a very strong case for the need for low-cost protein foods to feed the world's poor. But, in talking to pragmatic businessmen, one must speak of cash markets. There is a large cash market available for low-cost protein foods if we are only clever enough to create the products to serve these markets.

In 1970, a market research survey made by two economists at Cornell University identified sixteen food product categories containing protein ingredients[2]. They concluded that there was an untapped market potential at that time estimated to be between 4.5 and 5.0 billion pounds of protein products. Four product categories accounted for 86% of the market potential. There were dairy products, baked goods, pet food, and processed meat. In addition, it was predicted that protein extenders and analogs might attain 10% of all domestic meat consumption by 1985. This anticipated growth would carry protein ingredients used in the meat industry from the 1970 level of 145 million pounds to 2.45 billion pounds in just fifteen years. In 1970, even those people closest to the action might have thought those predictions to be somewhat optimistic. Today, they might be considered conservative.

Most of you are probably familiar with the approved use of textured vegetable protein as a replacement for 30% of ground meat in school lunches. This was followed in the past year by sales of blends of ground meat with textured vegetable protein from the meat cases in many large supermarkets. A market survey has indicated both consumer acceptance of and satisfaction with these blends[3]. When one considers the fact that last year, the sales of ground beef in the United States probably exceeded seven billion pounds, it is not difficult to visualize the use of two billion pounds of hydrated textured vegetable protein products in this one application within a decade. It is an interesting coincidence that this is approximately the same weight (i.e. two billion pounds) of meat that was imported into the United States last year. This resulted in an outflow of well over a billion dollars. It seems that most reasonable people in the United States should prefer to see this money flowing to the farmers and food processors of our own country.

To this point in time, soybean products have enjoyed all of this new business. All of these food applications, presently held exclusively by soybean

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[2]Hammonds, T. M., and D. L. Call. Utilization of Protein Ingredients in the U.S. Food Industry. A.E. Res. 320, July 1970, Cornell University, Ithaca, N.Y.

[3]Shafer, C. E. Private communication.

products, offer new opportunities for cottonseed and its products. While the soybean products have the advantage of having been there first, for many purposes they may not be the best. Further, it is our impression from conversations with people in the soy products industries that they are now selling at about their maximum plant capacities. Consequently, to meet further increases in demands they will need to add to or build new factories. There is no reason that the cottonseed industry cannot build new factories as rapidly as the soy in order to participate in this growth market.

The Food Protein R&D Center at Texas A&M University has as its primary objective the implementation of this participation by the cottonseed producers and processors in the expanding food markets. Our cottonseed research program has been supported by the Natural Fibers and Food Protein Committee of Texas, the Texas Engineering Experiment Station, the U.S. Department of Agriculture, and by Cotton Incorporated. We sincerely appreciate their support and call attention to the fact that without it we could accomplish nothing.

There are several guidelines in our selection of areas of research activity. First, we try to identify and exploit new product opportunities. Second, we try to identify and eliminate barriers to the successful marketing of cottonseed in food products. Finally, we make a deliberate attempt to avoid duplication of areas of investigation in other research centers, principally the USDA research center in New Orleans.

Fortunately, technological developments, principally in the U.S. Department of Agriculture, have eliminated gossypol as the deterrent it has been for so many years. Many new varieties of cottonseed devoid of gossypol have been developed over the past fifteen years (Figure 1). Further, a new process, which is the basis for the Lubbock plant, has been developed for the nearly quantitative elimination of gossypol from traditional seed[4]. Consequently, our attention has been focused principally upon glandless seed and degossypolized cottonseed flours.

When we first looked at clean, hull-free glandless cottonseed kernels, they looked "good enough to eat" (Figure 2). This has proven to be the case. We found that when fried or toasted, glandless cottonseed kernels (which we call TAMUNUTS) have a nut-like flavor and texture. We have distributed thousands of little packets of TAMUNUTS, and our "customers" keep coming back for more. We have tested TAMUNUTS in a whole host of food systems (Table 1). We have evaluated these in both informal and formal panels. We don't have a whole lot of trouble collecting informal panels. They seem to accumulate like bees in clover when the odors emanate from the experimental kitchen. In order to obtain more objective data, we also have set up varieties of types of more formalized panels. The consumer test data have been consistently favorable (Table 2). These data, based on a scale from one to seven, indicate that the great majority of the people liked the products. They look good too (Figures 3 and 4). All of these products were created by Mr. J. T. Lawhon and his associates. One product, shown in Figure 4, is especially novel. Rice is a staple in many countries of the world. It is somewhat deficient in protein. Mr. Lawhon and his staff got the idea of blending glandless cottonseed kernels with rice, which makes very good

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[4]Vix, H. L. E., P. H. Eaves, H. K. Gardner and M. G. Lambou. Degossypolized Cottonseed Flour - The Liquid Cyclone Process. J. Amer. Oil Chem. Soc. 48:611 (1971).

since nutritionally. Most people who have sampled the product liked both the taste and the texture.

You will recall an earlier comment that clean, hull-free glandless cottonseed kernels look good enough to eat. This is not true if any significant amount of hull material is retained by the kernels. There has been no great motivation in the past to produce hull-free kernels, and therefore there was no known technology. We considered this to be a significant deterrent to the use of cottonseed in food products and, therefore, undertook to develop processes for the production of clean kernels. This project is nearing completion, and we feel that it has been successful (Table 3). Mr. Clark and Mr. Weiderhold of our staff and Dr. Bailey and Professor Noyes of the Mechanical Engineering Department collaborated on this project. Using traditional cottonseed equipment, we can recover about 90% of the kernels as whole kernels or as large fragments. If about 6 to 7% linters are left on the seed, the amount of hulls can be reduced to about 0.2%. Dr. Bailey and his co-workers have built a pilot huller based on the principal of differential rolls (Figure 5). Because one of the rolls is fabricated from hard rubber, preliminary indications are that dehulling can be obtained with less fracturing of the kernels and, consequently fewer fines. It is in the fines fraction where separation of particles of kernels from hulls becomes essentially impossible using traditional equipment. We have demonstrated that a fair separation of the fines can be obtained either in a liquid cyclone or by electrostatic separation.

Two important product lines that have been developed in the soy industry are protein isolates and protein concentrates. Most commonly, these are produced in aqueous systems. The Southern Regional Research Center has developed several procedures in aqueous systems for the preparation of several classes of cottonseed protein isolates[5]. The Food Protein R&D Center has also developed a process for the production of cottonseed protein concentrates by aqueous extraction methods. In both cases, there is a byproduct of water soluble proteins, carbohydrates, and salts, which can become a waste and a pollutant (Figure 6). Note that in the upper portion of the schematic diagram is shown in simplified form the processes developed by the Southern Regional Research Center for the production of cottonseed protein isolates. On the far right is the whey, which is a waste byproduct. To the best of our knowledge, much of this is still being wasted at the present time in the manufacture of both soy protein isolates and concentrates. A group headed by Mr. Lawhon and Dr. S. H. C. Lin are investigating the possibilities of recovering marketable products from the cottonseed wheys to prevent them from becoming a waste and a pollutant.

The lower area of the schematic indicates the approaches being taken. The first step is ultrafiltration to remove the whey proteins. The filtrate is then concentrated by reverse osmosis to yield a concentrate of sugars and salts. The water that remains has been sufficiently purified that it can be recycled back into the process. Experimentally, we have run this through as many as five cycles of the production of isolates, recovery of water from the whey, followed by recycling the water back to the recovery of isolates, etc. There have been no indications that the recycled water adversely affected the isolate

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[5]Martinez, W. H. and L. C. Berardi. The Technology of Cottonseed Proteins. In "Proceedings of the 20th Oilseed Processing Clinic," p. 51, USDA, ARS 72-93 (1971).

recovery process or the quality of the products. It is especially noteworthy that there is no waste effluent from a closed process of this sort. A similar approach is successful with the whey recovered from the production of cottonseed protein concentrates.

A measure of the significance of this investigation is that in the most efficient of the isolate preparation processes the whey contains 30.5% of the original solids and 22% of the original protein of the starting cottonseed flour (Figure 7). Obviously, this would represent both an important economic loss and a serious disposal problem.

A pilot scale version of a commercial ultrafiltration-reverse osmosis unit has been used in these investigations (Figure 8). The unit has a multitude of separation cylinders. It can be operated in different configurations but, in general, we use half of the cylinders covered with ultrafiltration membranes and half with reverse osmosis membranes. While we have already attained favorable fractionation of the components on a continuous basis, membrane technology is advancing steadily and we are optimistic that even more selective and more efficient separations will be attainable in the future.

We are quite enthusiastic about the product obtained from the ultrafiltration step. That from our present technology contains in excess of 70% protein. When more selective membranes become available, we anticipate that this may go as high as 90%. The present product has some very attractive properties. When put into solution in water it whips very much like egg whites (Figure 9). The whipped foam is sufficiently thick that it can support the weight of a vertically suspended pencil. This whipped foam does not coagulate with heat as does that produced from egg whites. Therefore, it cannot be considered a complete substitute. However, we do believe that it has wide potential for use in whipped toppings where heat coagulation is not critical. In angel food cakes, where heat coagulation is important, we have been able to replace up to one-third of the egg whites with cottonseed whey proteins.

Additionally, these whey proteins are very soluble in water. Therefore, we have looked at the possibility of their use as a protein nutrient in beverages. We have added them in graded levels to Tang and to Kool-Ade. At the highest level tested in a taste panel, that is 3%, the panelists could not distinguish between the beverage with and without the added protein.

The soybean industry developed protein concentrates as low-cost alternates for protein isolates. In applying the same principles to cottonseed flour, we have recovered a whippable extract as described above and a cottonseed protein concentrate that has properties that should be marketable. The concentrate contains about 73% protein on a dry basis. There is some basis for speculating whether the whippable extract might be the byproduct of the concentrate or vice versa.

Perhaps the hottest item in the food industry today are textured soy proteins. They offer the consumers a double benefit when blended with ground meat. The textured soy protein products have the capacity to retain both moisture and fat. When one makes a meat loaf or meat pattie, there is less product loss by drippage. Therefore, the loaf or pattie containing the textured soy protein will shrink less on cooking. This results in the double benefit of a reduced cost for the raw materials and an increased yield of consumable product.

We have initiated a project to determine whether equally acceptable products can be made by texturizing either glandless cottonseed flour or LCP flour. For this purpose we have been using a laboratory scale Wenger extruder. The products obtained from the cottonseed flours differ from those obtained from soy flour. Those from cottonseed flour are less fibrous, more puffed, and have a

lower bulk density. When the operating conditions of the extruder are changed, differing products result. We have not yet succeeded in producing a textured product as fibrous and compact as can be obtained from soy flour. There are somewhat mixed reactions to this difference. The low bulk density could be an advantage in a product that is being sold at retail or that is to be blended into a snack item. However, for products that are to be sold on the commercial market for blending with meat in large-scale operations, the low bulk density becomes a disadvantage in its increased packaging and shipping costs. Therefore, means are being sought to produce a more fibrous textured cottonseed protein with a heavier bulk density.

The textured cottonseed products that have been produced to date have performed rather well in meat patties and meat loaves. The improvement in drip loss is comparable to that obtained with good quality commercial textured soy products. As an example, a test loaf in which 30% of the meat was replaced by hydrated textured cottonseed flour had three ounces more of servable portion than did the control loaf when we started with one pound of meat or of meat blend. In other words, this represents about one additional serving per pound of meat blend. Without having done an exhaustive statistical comparison, it is our general impression that the textured products from cottonseed flour and LCP flour behave about the same as commercial textured soy protein products in terms of reduced shrinkage. Also, the flavors are comparable. All were as well accepted by consumer panels as were the control meat loaves. Similar acceptance data have been obtained with meat patties. There are some indications of preferred tenderness and juiciness in those products containing the textured vegetable proteins.

There is a problem that we believe will be a deterrent in some of the potential markets for cottonseed protein products. This is due to the nongossypol pigments in the cottonseed. If one looks at the flours obtained from various oilseeds, it can be seen that glandless cottonseed flour is slightly darker than soy flour. This becomes aggravated in the production of protein isolates or concentrates. It becomes even more serious when the flour is wetted with water (Figure 10). Note in the color chart that glandless cottonseed flour and LCP flour are only slightly darker than wheat flour in the dry state. Wetting darkens both much more than wheat flour and enhances the difference between glandless cottonseed flour and LCP flour. Food product applications where this darkening could be a deterrent would be infant cereals and other cooked cereals. It has also been shown to be a disadvantage in baked goods such as bread. We are trying to determine the nature of the pigments that cause these problems as a tool to be used in developing technologies for the prevention or elimination of discoloration. We know that the pigments that cause the problem are not loosely bound because they are not readily extracted by organic solvents (Figure 11). Note that the flour that has been extracted with isopropanol is not dramatically improved over the control. On the other hand, an exhaustive hydrolytic extraction with oxalic acid in methyl-ethyl-ketone can remove most of the problem pigments. This is scientifically informative but not much help at this time in technological development. There is much more scientific investigation that will be needed before we can hope to undertake any informed technological development work.

Let us now turn briefly to an entirely different area of investigation. In a search for a practical method for detoxifying aflatoxin-contaminated peanuts and for the recovery of food grade protein from coconuts, we have developed what amounts to a new oil milling technology (Figure 12). This entirely bypasses

organic solvent extraction. In the example shown for the production of peanut protein concentrate, peanuts are ground, extracted with water, filtered to remove any undissolved solids and then passed through a three-phase centrifuge to recover water-washed peanut oil as one major product, a peanut protein concentrate as the second major product, and the inevitable whey. In the process as shown, over 90% of the oil is recovered in the oil phase, the remainder of the oil and over 90% of the protein is recovered in the concentrate, and the unprecipitable proteins, carbohydrates and salts are in the whey. Dr. K. C. Rhee, the leader on this project, estimates a manufacturing cost of the concentrate to be about 19¢ per pound.

If the peanuts contain aflatoxin, this can be quantitatively destroyed by use of either hydrogen peroxide or sodium hypochlorite (Figure 13 and 14).

This has been brought into this discussion because Dr. Rhee believes that the aqueous process can also be applied to glandless cottonseed. Preliminary laboratory investigations strongly suggest this is feasible. We hope to be able to put more effort into this investigation within the next year.

In closing, the point should be made that we do not work either in a vacuum nor in an ivory tower. It is our working philosophy that a project is not completed until it is being used commercially. Therefore, a deliberate and positive effort is made to inform the food industry of any new developments which we think might be of interest to them. We are now receiving some signals that our efforts will begin to pay off in new industries, new jobs, new and more profitable markets for cottonseed, and improved low-cost protein foods.

TABLE 1.--Miscellaneous use items prepared with TAMUNUTS

Food Types	
Candies	TAMUNUT brittle, patties, pralines, glazed nut clusters, chocolate nut clusters
Baked Goods	Cookies, brownies, sweet rolls, muffins
Consumption Snack	Salted TAMUNUTS, TAMUNUT-popcorn mixture, crackers
Spreads	TAMUNUT butter, salad dressing
Breads	Cracked wheat-type with TAMUNUTS
Pies	TAMUNUT pie (pecan type)
Dessert Topping	Salted nuts with mellorine, hot chocolate pudding
Vegetable Dishes	TAMUNUTS with rice

TABLE 2.--Summary of customer test data

Food Items	No. Persons Scoring	Total Numerical Score	Mean Score Received
Brownie	115	584	5.1
Fried TAMUNUTS	50	236	4.7
Toasted TAMUNUTS	89	462	5.2
Candy Cluster	75	369	4.9
Cookie	52	244	4.7
All Items Combined	381	1895	5.0

TABLE 3.--Yield and composition of combined coarse kernel fractions: Mean for five varieties

From high linters seed	Mean	Std. dev.
Yield, as % of total kernels in seed	90.5	3.0
Composition		
-kernels, %	99.79	0.08
-hulls - loose, %	0.17	0.09
-hulls from unhulled seed, %	0.04	0.04
-total, %	100.00	
<u>From low linters seed</u>		
Yield, as % of total kernels in seed	90.1	4.3
Composition		
-kernels, %	99.16	0.54
-hulls - loose, %	0.34	0.41
-hulls from unhulled seed, %	0.50	0.21
-total, %	100.00	

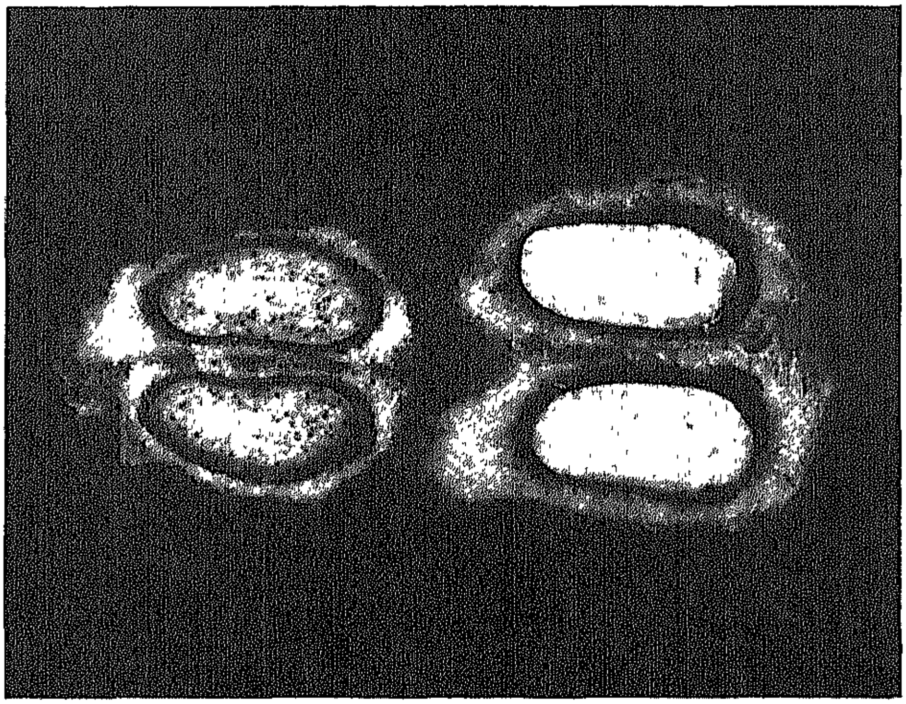


Figure 1.--Glanded and glandless cottonseed.

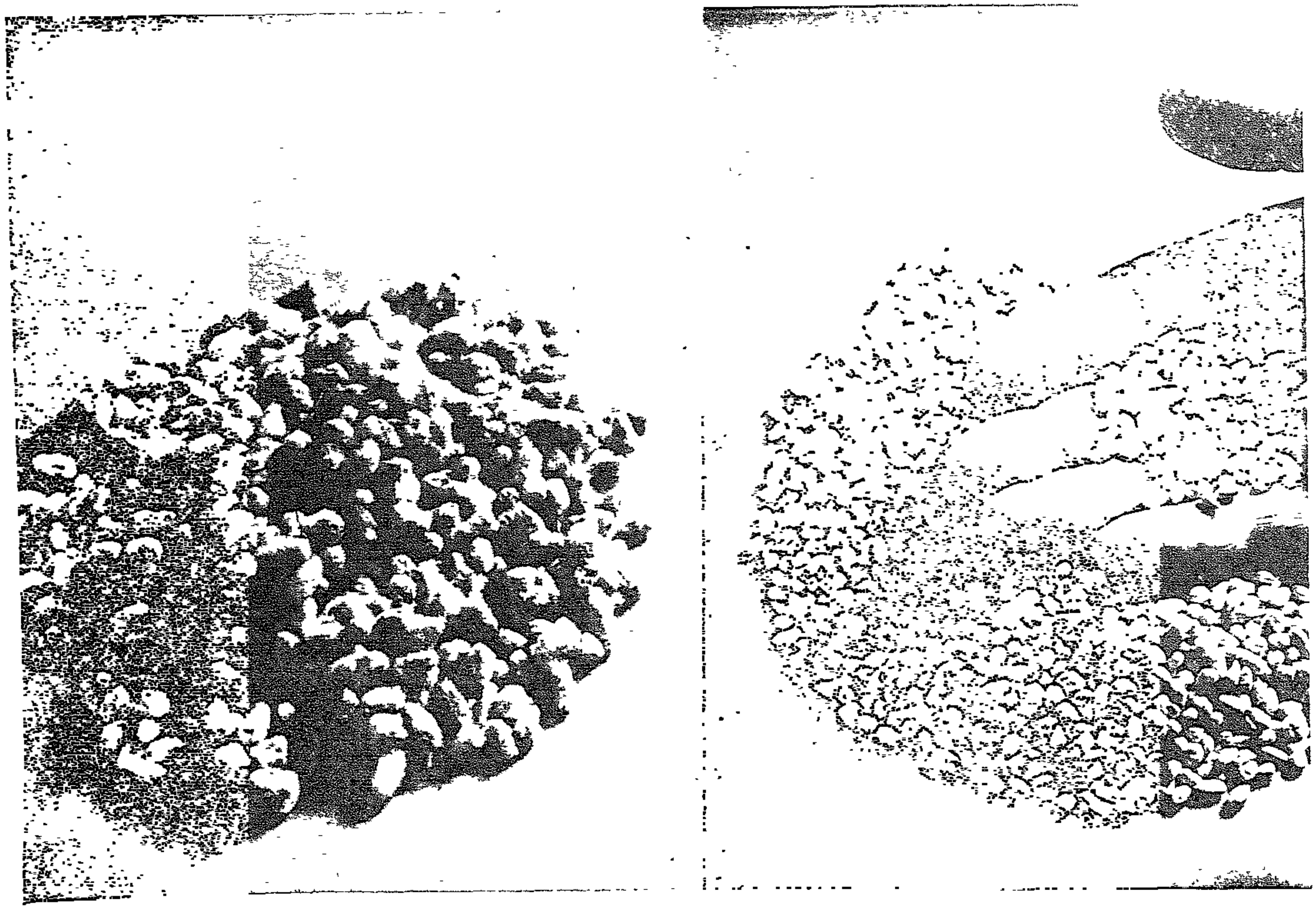


Figure 2.--Glandless cottonseed and kernels (photo courtesy the Progressive Farmer).

Figure 3.--Snacks and confections containing TAMUNUTS (photo courtesy The Progressive *Farmer*).

Figure 4.--Rice and bread fortified with glandless cottonseed kernels and flour, respectively (photo courtesy The Progressive Farmer).

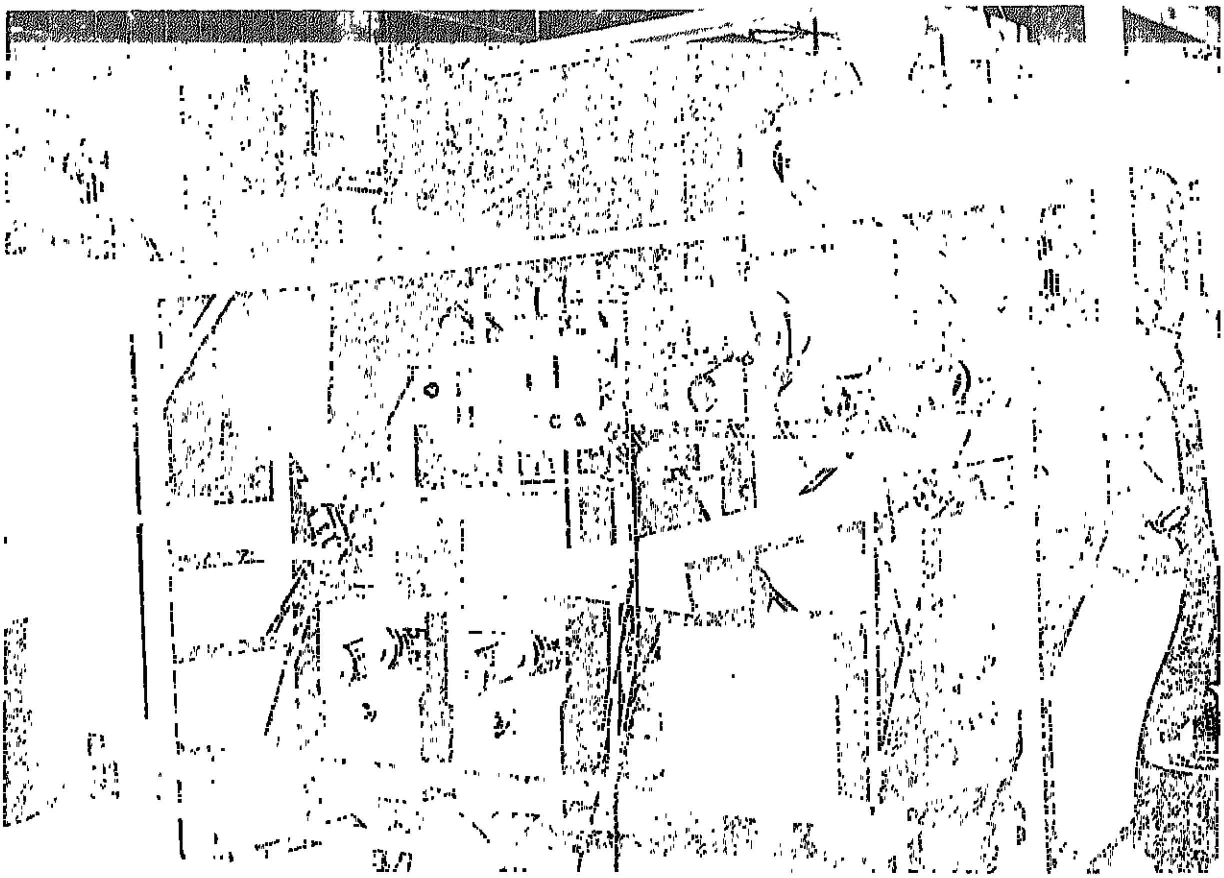


Figure 5.--Experimental roller huller.

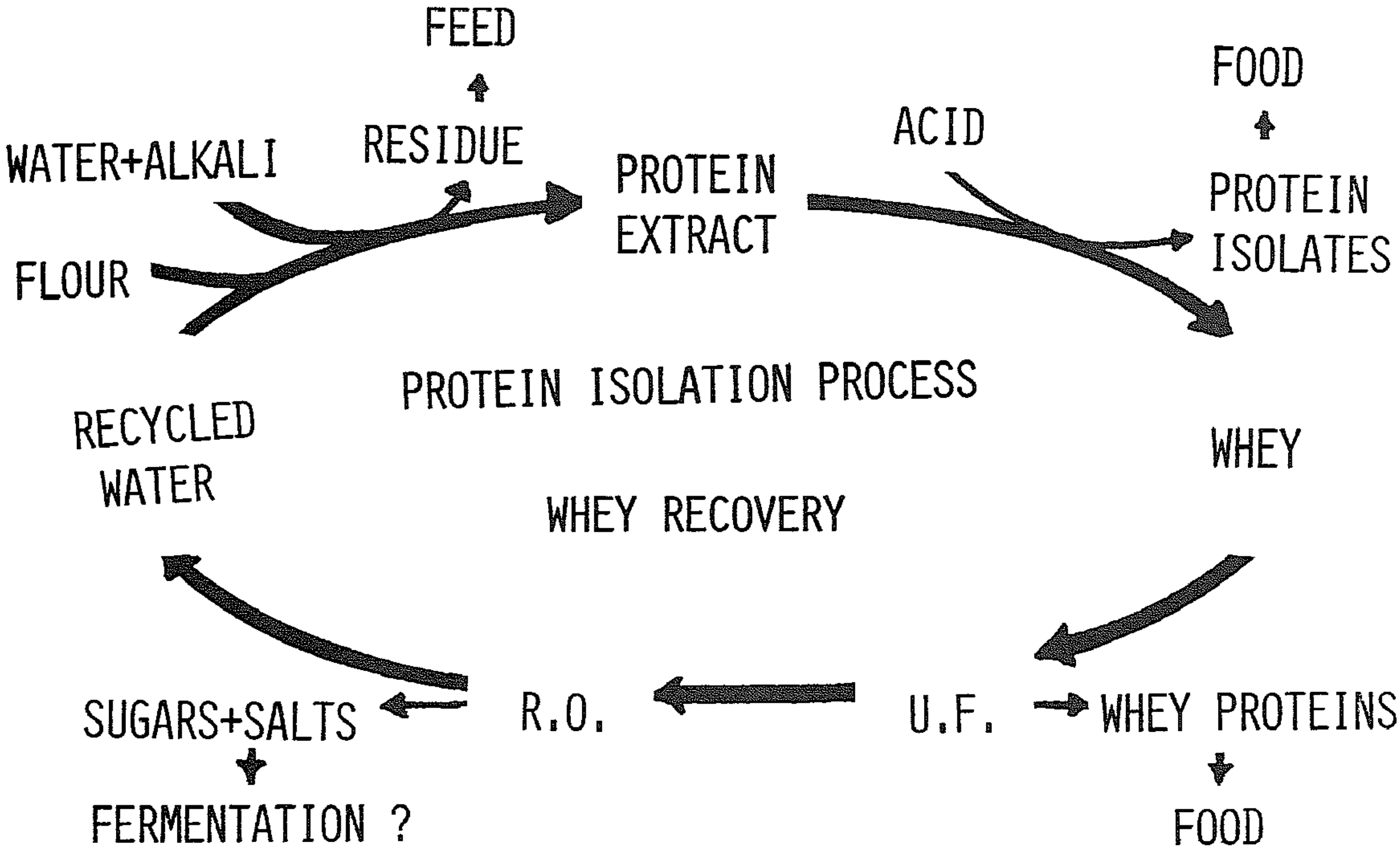


Figure 6.--Schematic of closed process for preparation of cottonseed protein isolates, recovery of solids from "whey," and reuse of process water.

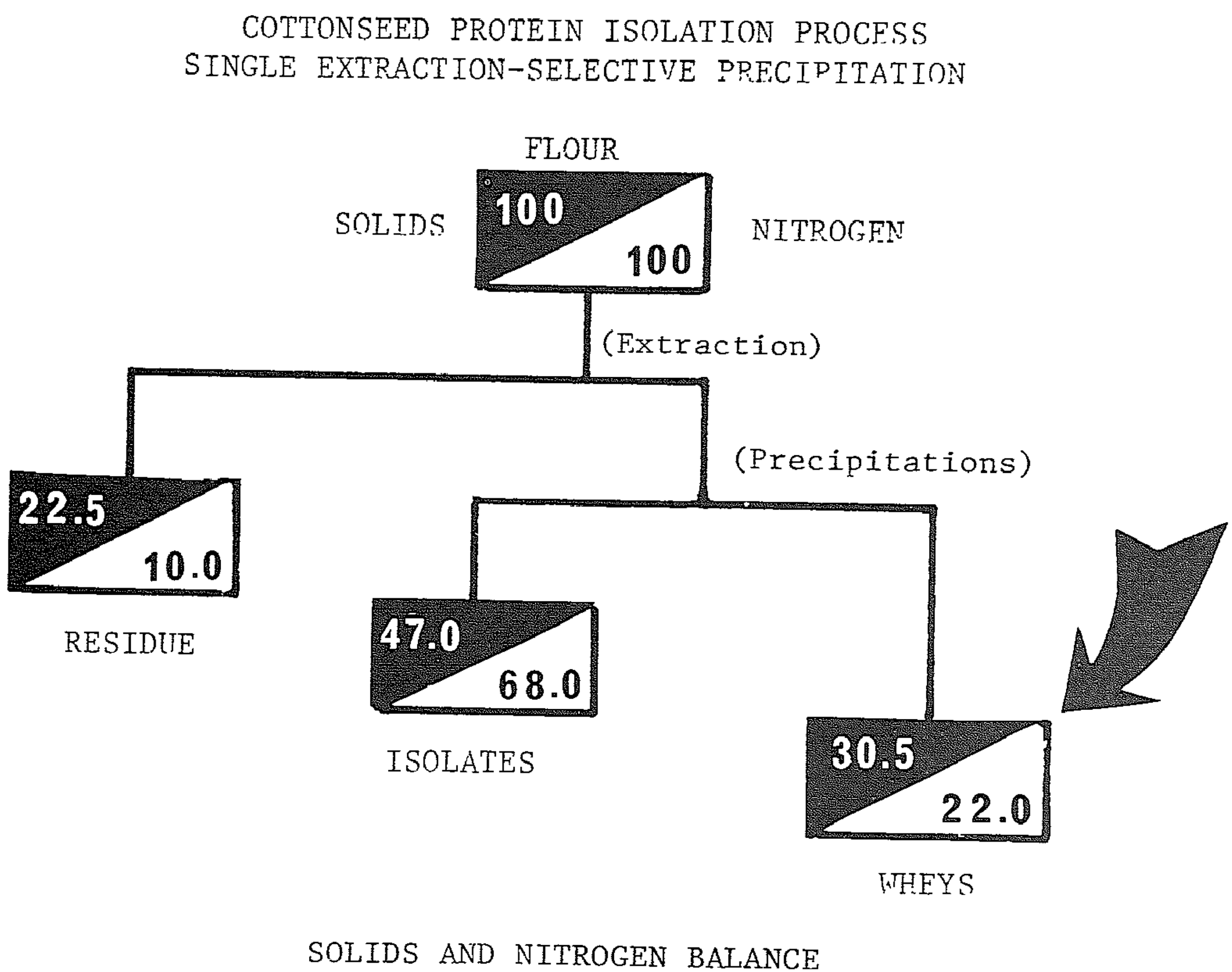


Figure 7.--Cottonseed protein isolation process single extraction - selective precipitation.

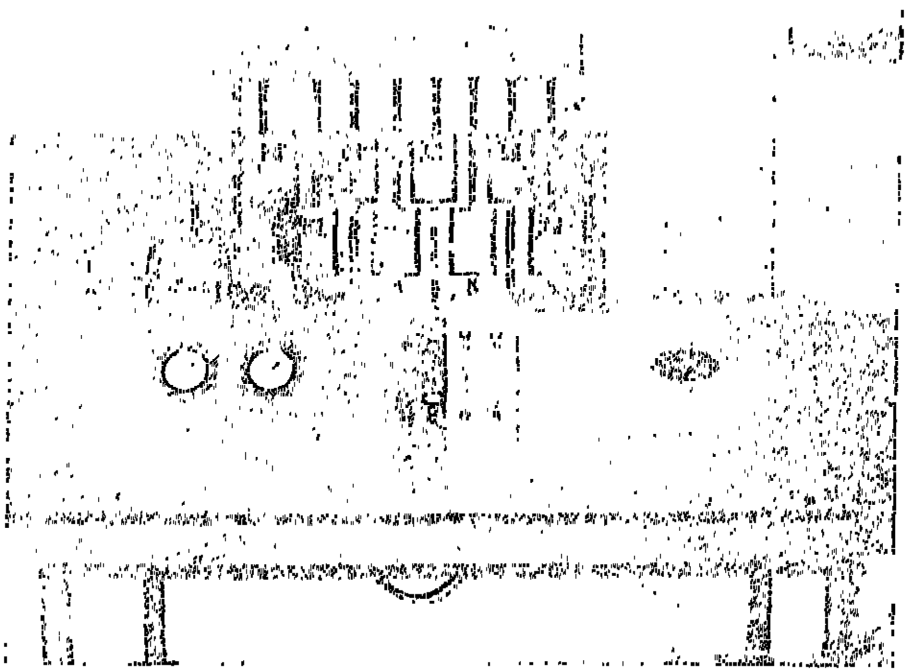
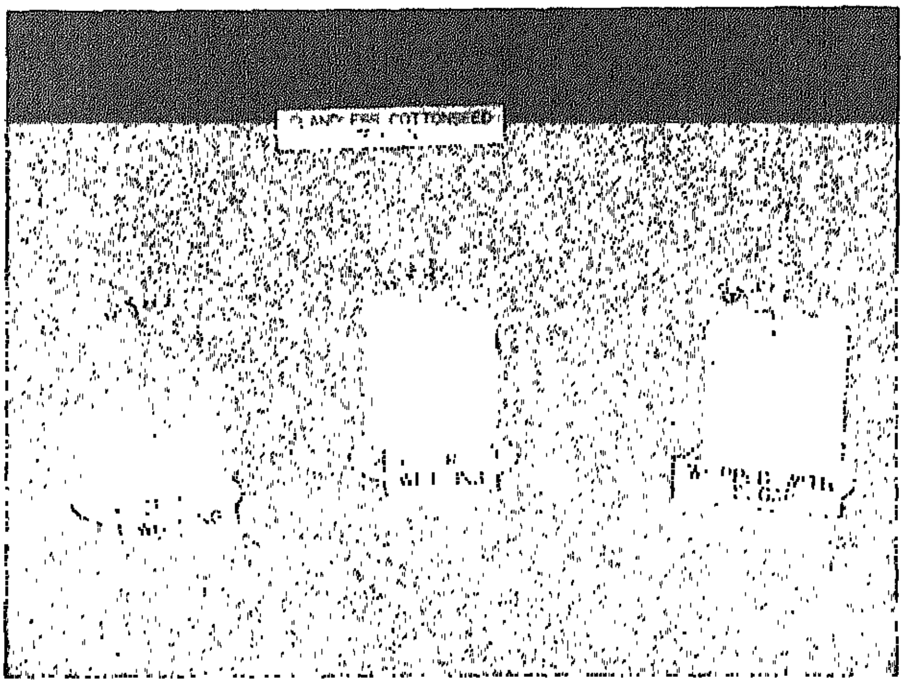


Figure 8.--Pilot scale ultrafiltration-reverse osmosis (UF-RO) unit.



igure 9.--Whippable extract from glandless cottonseed.

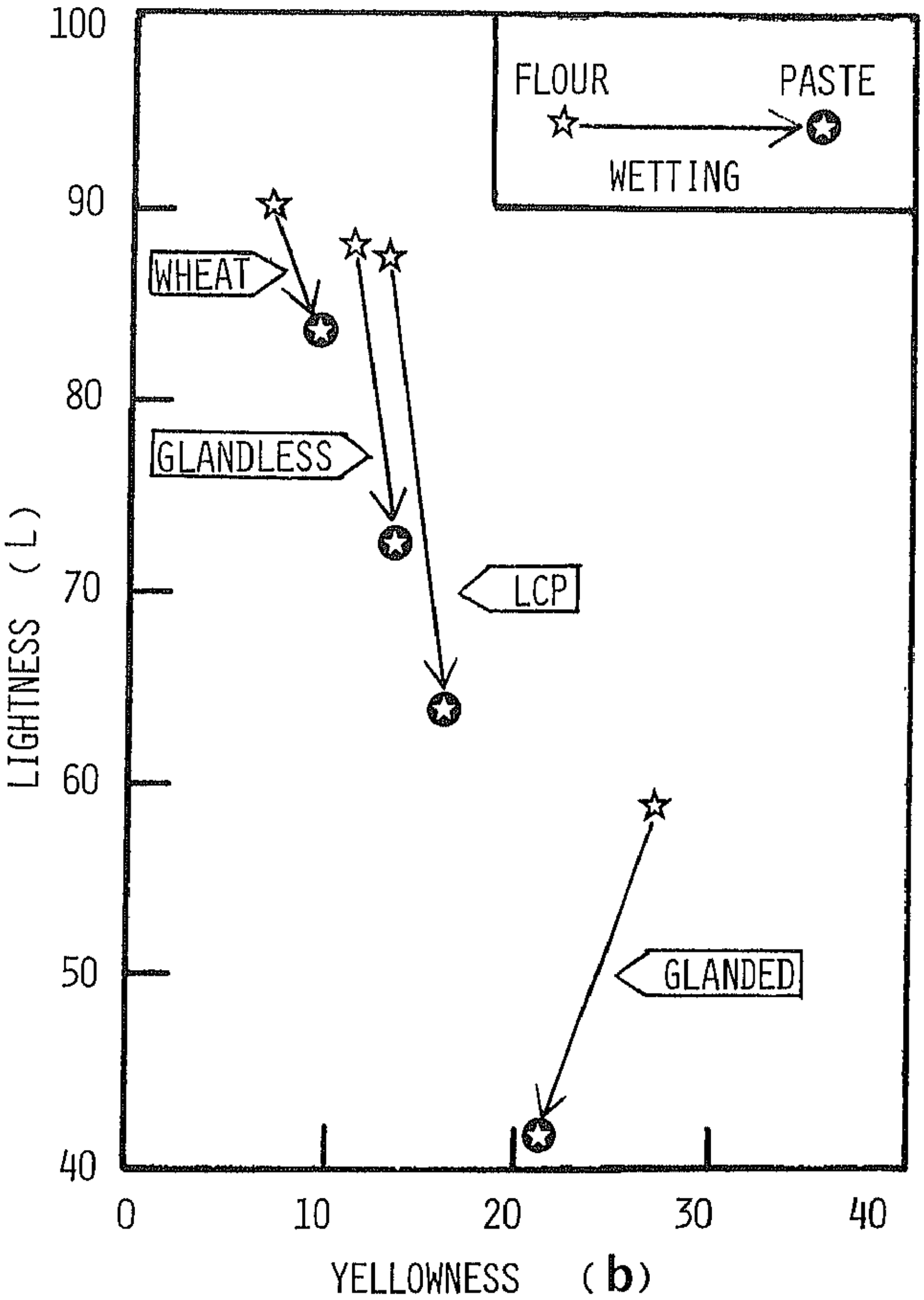
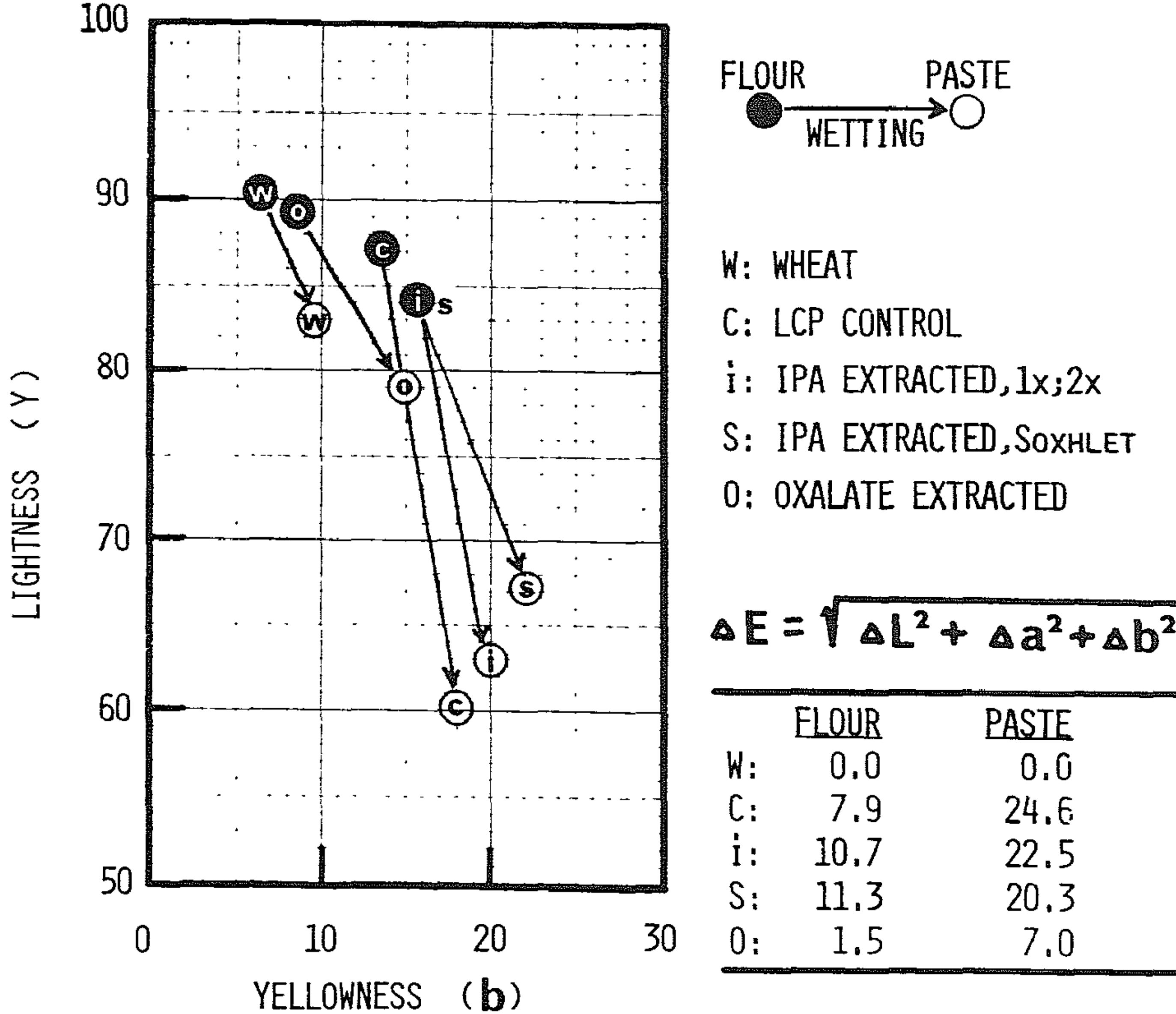


Figure 10.--Color measurements of wheat flour and cottonseed flours, dry and wetted.



$$\Delta E = \sqrt{\Delta L^2 + \Delta a^2 + \Delta b^2}$$

	FLOUR	PASTE
W:	0.0	0.0
C:	7.9	24.6
i:	10.7	22.5
S:	11.3	20.3
O:	1.5	7.0

Figure 11.--Effect of extraction with organic solvents on color of LCP flour.

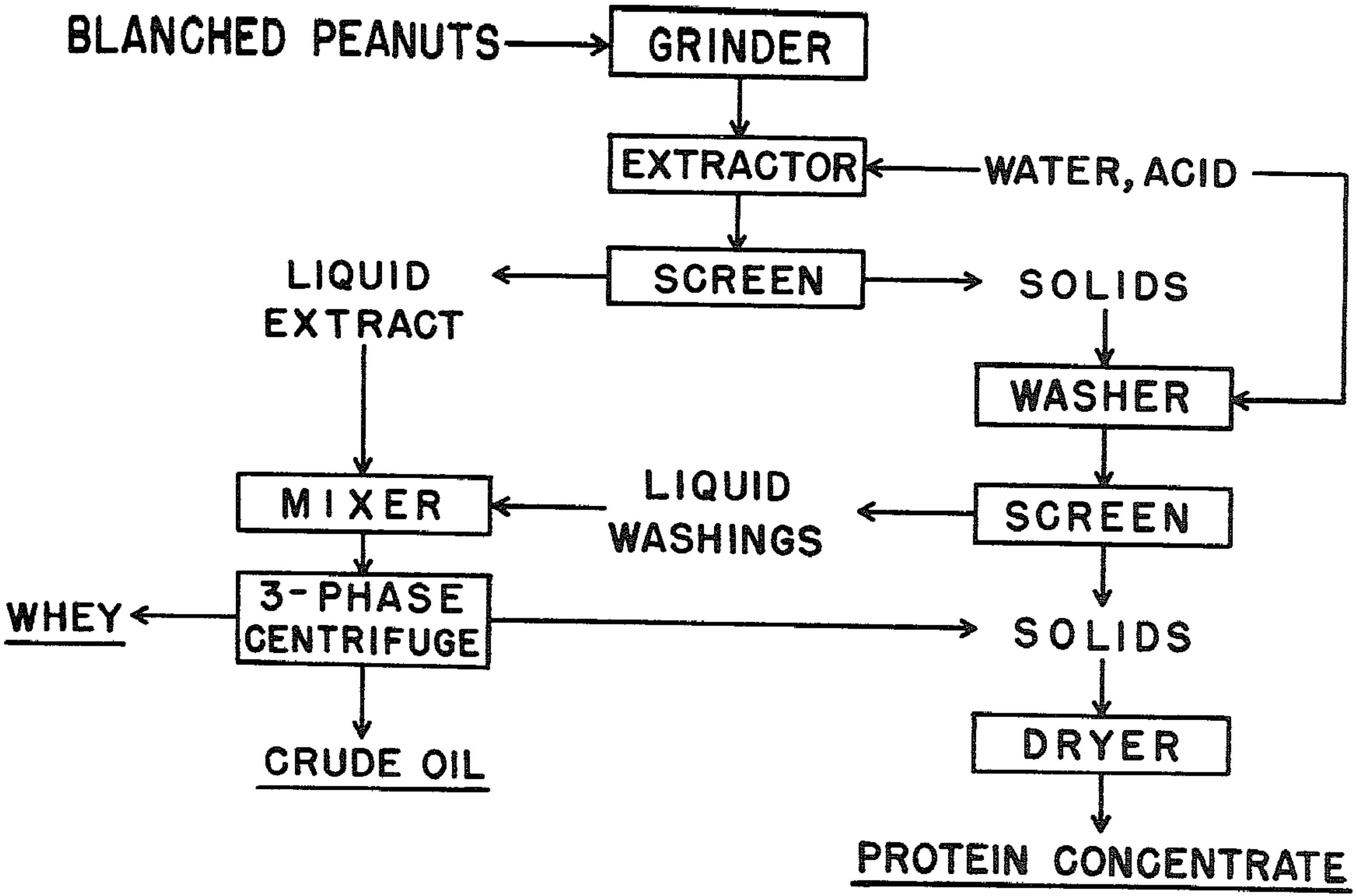


Figure 12.--Aqueous process for production of peanut protein concentrate.

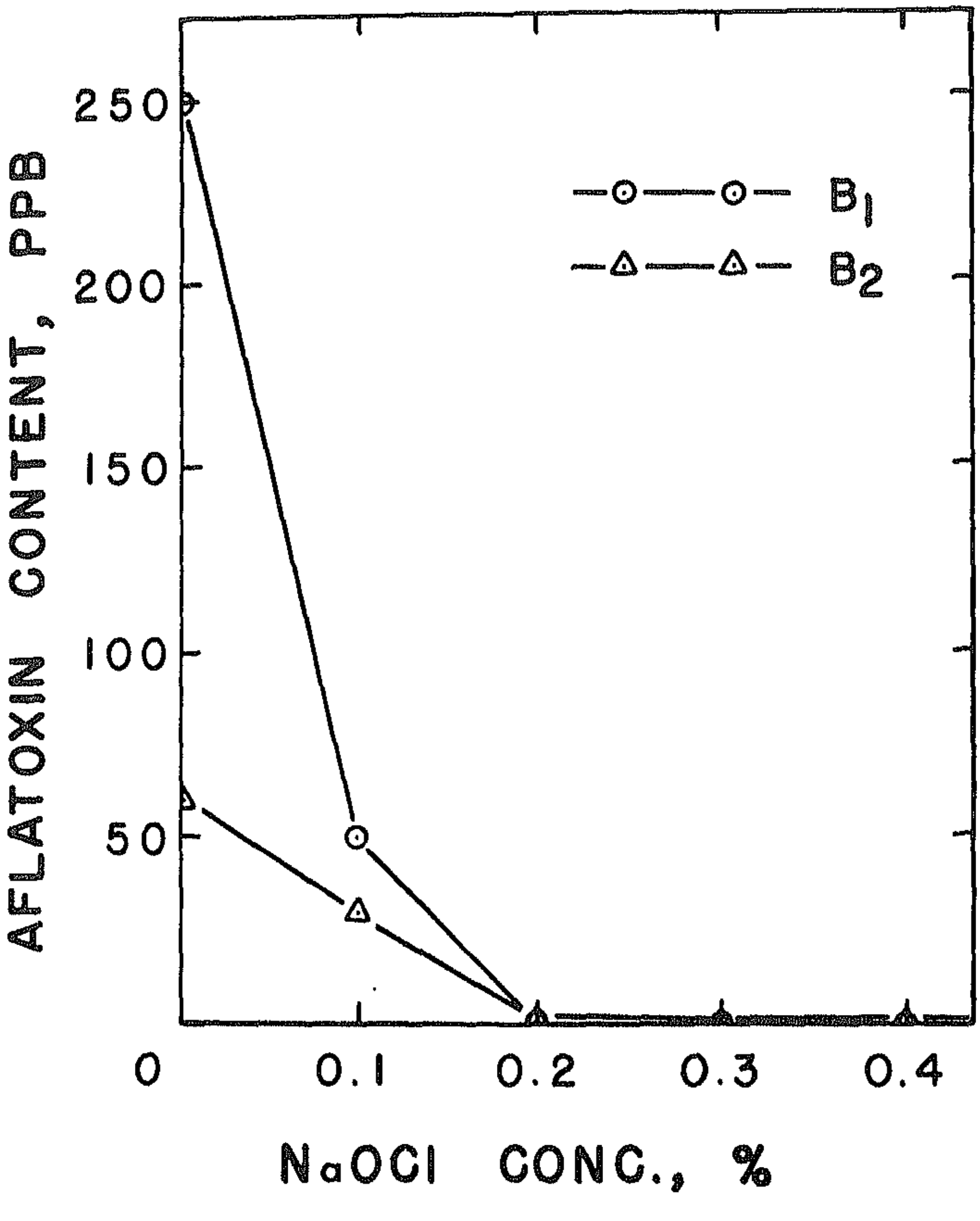


Figure 13.--Effect of use of sodium hypochlorite in aqueous process on aflatox content of recovered peanut protein concentrate.

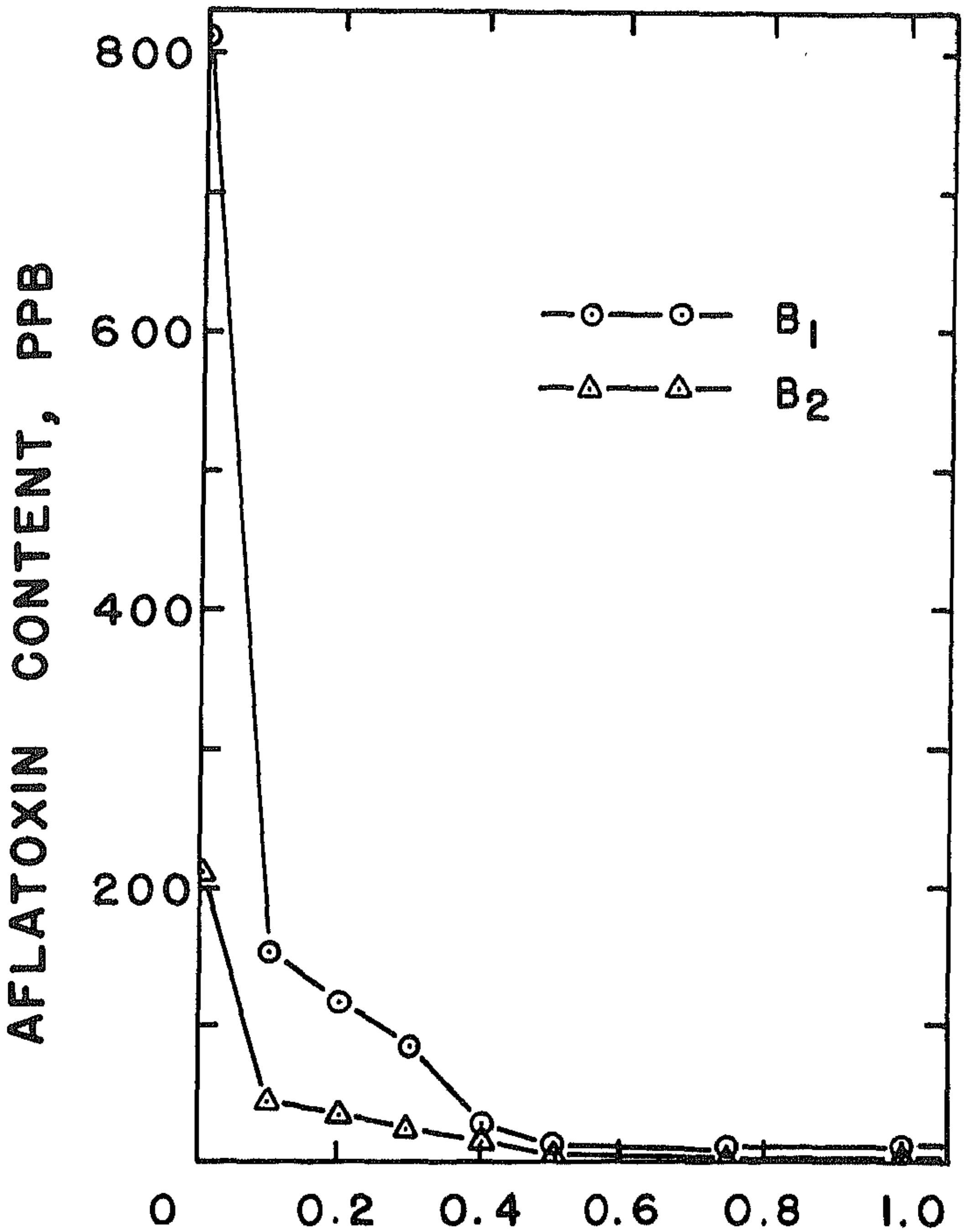


Figure 14.--Effect of use of hydrogen peroxide in aqueous process on aflatoxin content of recovered peanut protein concentrate.

PROGRESS REPORT OF COTTONSEED RESEARCH AT SOUTHERN REGIONAL RESEARCH CENTER

By Wilda H. Martinez[1]

It is always a genuine pleasure to have the opportunity to share our program with you - the members of the Oilseed Processing Industry. The objectives of our program at the Southern Regional Research Center can be summed up in two words - problems and potential, that is, to recognize, characterize, and solve problems which threaten cottonseed and the oilseed industry, and to develop the full potential of cottonseed in terms of products, the requisite processes, and product characterization which will ultimately benefit all - the farmer, the consumer and the oilseed industry.

This morning I would like to describe our program to you within the framework of the seed itself (Figure 1). This, of course, is a view of a cottonseed cut lengthwise. The first thing we encounter on the seed are the remaining short fibers - the linters. Work on various aspects of the problems associated with the linters - dust control, cost of delintering, and new approaches for removal are presently supported by the Agricultural Research Service, USDA at Texas A&M.

The question with respect to linters really appears to be one of to be or not to be. Are linters, even at today's increased prices, of sufficient value to countermand the undesirable production problems which include large energy demands and specific equipment unique to only one oilseed, or should perhaps the directive be given to the cotton geneticists to eliminate linters?

On one hand there is indeed a very real potential for cotton linters and Mr. Knoepfler and coworkers of the Engineering and Development Laboratory have been making great progress in providing cotton batting materials which will meet the required flammability tests for upholstery and mattresses (5). Agents, such as boric acid, have been developed for cotton batting which impart smolder resistance sufficient to pass the Mattress Flammability Standard FF4-72. However, even with this market, a total economic assessment at today's prices should be made weighing the return for cotton linters against the total cost of processing including energy requirements, labor, equipment maintenance, and dust control. Only then can we truly determine the value of cotton linters.

The next thing we encounter is the hull. In today's roughage market and at today's prices, one could easily say, there is no problem with the hull, that is, other than those already noted with respect to air pollution. If, however, one is interested in producing edible protein products - the hull content of cottonseed meats is important and must be reduced to a maximum of 2 to 3% or less. Very productive research on hull removal is presently underway at Texas A&M. With this problem, however, we cannot very simply say to the geneticist - eliminate the hull, for the hull supports the growth of the fiber and also provides very effective protection for the seed kernel.

It is circumvention of the protective barrier of the hull which has provided the cottonseed industry with one of its most serious problems - namely

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aflatoxin - the toxic metabolite resulting from fungal infestation of the seed. Fortunately for the cottonseed industry, aflatoxin contamination has been limited primarily to certain specific areas. Although at times it has been a major problem in these areas, in 1973 aflatoxin contamination was less severe than usual. Unfortunately, this does not lessen the problem. Molds can proliferate and produce toxic metabolites in most, if not all agricultural commodities, given the proper environmental conditions of temperature and moisture or relative humidity favorable for their growth.

The complexity of this problem might be illustrated by considering the task of identifying and selectively removing that one seed in 30,000 which contains 900 ppm aflatoxin and would subsequently provide in the cottonseed meal a level of aflatoxin considered actionable by the Food and Drug Administration.

Our research approach to this problem in two-fold -- (a) the development of methods for detection and determination of aflatoxin in cottonseed products and animal products spearheaded by Mr. Walter Pons, and (b) the development of methods for inactivation or removal of aflatoxin from cottonseed meal headed by Mr. Frank Dollear in the Oilseed and Food Laboratory, and Mr. Homer Gardner in the Engineering and Development Laboratory.

A recent contribution in the area of detection has been the development of a minicolumn procedure adapted from the original small column principle of C. E. Holaday. This procedure permits not only rapid screening of seed and segregation of contaminated lots as received at the mill but also monitoring of the processed meal. The method which is sensitive to 10 ppb involves rapid extraction in a blender, treatment of the extract with lead acetate, partition into benzene and separation on a dual media column of alumina and silica gel about four inches in length (12). The column is then scanned under UV light for the presence or absence of aflatoxin.

In addition to this method we have also provided an improved method for the determination of aflatoxin in cottonseed products (13), a method for the determination of aflatoxin in mixed feeds (14), and a method for the determination of aflatoxin M_1 which is a ruminant variant of aflatoxin B_1 found in fluid milk and milk products from cows fed contaminated feeds (15). Two of these methods (13 and 15) are official methods of the Association of Official Analytical Chemists. In addition we are now developing methods for the determination of aflatoxins in eggs and animal tissues as part of the evaluation studies on our methods for the elimination of aflatoxin from cottonseed meal.

With respect to inactivation, we have found that treatment with anhydrous ammonia will essentially eliminate the aflatoxin content of contaminated cottonseed meal. Under appropriate conditions of about 12-15% moisture, 40-50 lbs of ammonia, 30 minutes time, and a temperature between 200 and 250^{o}F, the aflatoxin can be reduced to very low levels with fairly good retention of nutritive value (3). One commercial plant operated an ammonia treatment system last year and another plant has been installed and is undergoing shakedown runs.

Although FDA has granted limited approval for feeding ammoniated cottonseed meals to chickens and to cattle, they have requested additional tests with laying hens producing marketable eggs. USDA and the National Cottonseed Products Association (NCPA) have contracted with the Ralston Purina Company to carry out the required feeding tests to establish both the animal safety and the human safety in consumption of products from animals fed ammoniated meals. This test will involve feeding meals to laying hens for a period of 9 to 10 months with observations on egg production, hatchability, and general health, and on the general pathology of the birds at termination.

Another group of chickens will be fed ammoniated meal for 60 days in order

to provide sufficient eggs and poultry meat for rat-feeding studies. These materials will be evaluated with rats in a lifetime feeding study and a reproductive study of at least two generations.

The results of an investigation into the products of the reaction between aflatoxin and ammonia by Mrs. Louise Lee and coworkers (6) indicate that the lactone structure of the aflatoxin has been modified. This is fortunate in that such a modification will not permit regeneration of the aflatoxin under the acid conditions of the stomach of the animal and suggest that the inactivation may truly be detoxification.

We are presently exploring two alternate approaches to elimination of aflatoxin, one, the use of formaldehyde with lime or alkali which may have some advantage in ruminant feeding, and two, the extraction with aqueous solvents such as the azeotrope of isopropyl alcohol and water. Limited tests made in the pilot plant at Crown Iron Works look quite promising. We have recently purchased an extractor and expect to initiate this research in the very near future.

In limited experiments supported by the NCPA, physical separation on the basis of size, density, and a cateye fluorescence has not proven to be an effective means for the separation of aflatoxin-contaminated cottonseed.

From the hull we proceed to the heart of the matter - the seed kernel. The quality of this seed kernel is important to you, the oilmill processors, in terms of yield and profit. It is important also to the production of edible protein products in terms of both the microbiological and the compositional quality of the products. There are various indications that a reinvestigation of the seed storage might be very pertinent at this time. However, such an investigation cannot be limited merely to storage at the oil mill site - it must be extended to the gin yard and even to the new field practices of rick and module storage of seed cotton.

Recent reports at the Cotton Production and Mechanization Conferences suggest that given the practicalities of the harvest situation - module and rick storage may significantly affect seed quality. At a recent meeting of the Research and Education Committee of the NCPA, Mr. George Cavanagh of Ranchers Cotton Oil reported that high-moisture seed can be handled quite effectively by spreading calcium or sodium proprionate on each truckload to inhibit mold growth. Also, a recent article in Cereal Chemistry (4) reported that the free fatty acids, such as propionic, could be effective against aflatoxin producing molds in grains.

At this time, I would also like to point out that there are two seeds in Figure 1 - one glanded and one glandless. In addition to the often listed advantages of glandless, it may be appropriate also to consider the energy advantages in processing glandless seed with respect to decreased cooking requirements.

The seed kernel provides, of course, the two major products of the oil mill processor, oil and meal. Accepted practices for refining and bleaching have continued to provide the quality product known as "cottonseed oil." However, again in these operations cottonseed oil from glandless seed could provide increased yields and decreased losses.

Research on cottonseed oil has now turned toward the development of new products, edible and industrial, specifically aimed toward needs in the market place. In the development of such products, proper characterization of the functional characteristics and a proper understanding of the determinants of these characteristics are requisite for maximum utilization. In the market place - today's shortage create today's needs.

Cocoa butter fats are a good example. Both the price and the shortage of cocoa butter fats make the conversion of stearine, the byproduct in the manufacture of cottonseed salad oil, to cocoa butter-like fats particularly

interesting. Not only can the extremely short melting range of cocoa butter be simulated, but the hardness characteristics also approach those of cocoa butter (7). Stearine can also be fractionated to obtain, in yields up to 65%, a product 90% of which melts at 82°F. It is believed that this product has potential uses as a specialty fat in coatings for frozen food items (8). Research in this area headed by Mr. R. O. Feuge has also developed new products and processes from sugar or glycerol glucosides and the fatty acids of cottonseed oil. These products, known as "sucrose esters" or "glycerol glucoside esters," potentially have many uses ranging from food emulsifiers to biodegradable detergents (1).

The expected shortage of products based on petroleum also places new emphasis on the development of industrial products by Dr. Gene Sumrell's group. Cottonseed oil offers unique advantages for industrial use because its predominant saturated acid is palmitic. Further, since cottonseed oil contains no linolenic acid, fractionation of the fatty acids is less complicated than for competing oils. The development of products from cottonseed fatty acids could provide an outlet for that portion of cottonseed oil which is too dark in color or too high in free fatty acids for fully satisfactory use in edible products.

Current research has shown that the amides of modified cottonseed oil fatty acids are excellent low-temperature plasticizers for polyvinyl chloride resins and other plastic materials (11). This result is particularly pertinent in view of the present concern over the widespread contamination of the environment by the plasticizers presently in use.

Another promising area for utilization of fatty acid derivatives is in the lubricants and lubricant additives area (9). Most of these materials are derived primarily from petroleum. As the stress on our petroleum supplies increases, it is reasonable to expect that our renewable sources of agriculturally derived fats and oils will obtain an increasing portion of this market.

It is to the other component of the seed kernel - the protein, to which I would now like to turn your attention. One could well ask why, with today's demand for feed proteins and the availability of edible soybean protein products, should one be concerned with the development of edible cottonseed protein products. The answer is simple - economics. The present demand for animal proteins plus the present economic, social, and environmental circumstances limiting the production of these products make it necessary to extend and complement our animal proteins with vegetable proteins. However, not all vegetable proteins are alike. Cottonseed proteins have certain distinct characteristics such as blandness in flavor, excellent nutritive value, and freedom from antinutritional factors such as trypsin inhibitors, which make their place in the edible protein market a certainty.

I am sure that you all have heard of the development by our engineers called the Liquid Cyclone Process (2). The interest and response of the public to this development and its commercialization by the Plains Cooperative Oil Mill have been overwhelming. There is no indication of an esthetic objection to making a food grade material from what is primarily a feed commodity.

The market for protein products however is not limited to one product, i.e., a flour. In the edible soy industry, products are marketed at three levels of protein - flours at 50% protein, concentrates at 70% protein, and isolates at 90% protein. We have devised procedures for making all three types of products from glandless cottonseed and most of these products from glanded (10). Highly acceptable glandless cottonseed flours can be produced with appropriate dehulling, defatting and desolventization techniques. Because of the relatively high proportion of hull and lipid in the cottonseed, a cottonseed flour approaches

60% protein, rather than the 50% protein in soybean flour. The protein content of cottonseed flour can be increased by either selective classification of the protein constituents or by extraction of the nonprotein constituents. Classification can occur in either air or liquid and is an inherent part of the Liquid Cyclone Process (LCP). The Liquid Cyclone Process is, therefore, unique in that it can provide several operations - classification of pigment glands, classification of protein and cell wall particulates, and removal of oil - all within a single process. With glanded cottonseed, the Liquid Cyclone Process provides only one edible product which at 65% protein is very near that of a concentrate. With glandless cottonseed, both a 70% concentrate and a 50% flour could be produced by either liquid or air classification procedures and thus provide two edible protein products.

Aqueous alcohol extraction can also be used to produce a concentrate from glandless seed. However, the problems of water pollution, solvent recovery, and denaturization of the product make this process relatively unattractive.

In the soybean industry, isolates with 90% protein are produced by aqueous procedures under conditions which provide maximum extraction and precipitation of the proteins in the defatted bean. This can also be accomplished with either the LCP flour or defatted glandless flour. However, we felt that rather than imitate soybean products, we should capitalize on the differences between cottonseed and soybean proteins and develop products which were unique in characteristics and potential end use. Therefore, we developed a number of procedures which separate the major storage proteins of the seed from the nonstorage proteins and provide selective rather than collective isolation. These procedures were evaluated on pilot plant scale under contract with the Ralston Purina Company, and significant quantities of the various isolates were prepared from both LCP and glandless cottonseed flours. Two of the procedures - Selective Extraction and Selective Precipitation - were found to be the most acceptable in terms of commercial adaptability, economic feasibility, and the inherent microbiological and pollution aspects of the methods.

In support of this work on cottonseed isolates, we have constructed a complete, stainless steel pilot plant facility including extraction tanks, desludging centrifuges, holding tanks, a pasteurizer and spray dryer, all of which are under the supervision of Mr. James Spadaro of the Engineering and Development Laboratory.

In view of present regulations in the Water Quality Act and EPA requirements for an environmental impact study for any new industry, resolution of the pollution problems associated with aqueous production of cottonseed isolates was considered to be highly important to the commercialization of these products. Consequently, a contract on methods for removal or utilization of cottonseed whey constituents has also been placed with Texas A&M University.

Part of the acceptability and success of the edible cottonseed products will lie in the processes for their production, but the primary determinants will be the product characteristics. Other than basic composition, the interest of the food industry can be divided into two areas - nutritional quality and functionality in the food system.

The production of cottonseed isolates by either of our procedures also fractionates the proteins and, as a result fractionates the nutritive quality. The nonstorage protein isolate is exceptionally high in nutritive value, the storage protein isolate relatively low. In a comparative rat study, the nonstorage protein isolate was shown to have a protein efficiency ratio (PER) of 3.1 compared to 2.5 for casein. This isolate has relatively poor solubility

characteristics and shows, therefore, great promise as an inert protein supplement for a variety of food systems such as bakery items and cereals.

In turn, the storage protein isolate, though low in nutritive quality, shows great promise in the area of functionality. Texture formation is a characteristic greatly prized by the food industry and, under the proper conditions of concentration and pH, the storage protein isolate will provide a variety of textures ranging from a chewy mass to a clear gel (Figure 2). In addition, the procedure offers the opportunity to incorporate fat, flavor, and vitamin and mineral supplements. We feel, therefore, that where desired, this isolate offers the potential of a totally fabricated diet with controlled flavor, protein and polyunsaturated fat all within an acceptable texture, and is an interesting alternative to spun and extruded products.

In addition to chewy texture, the storage protein isolate has other interesting characteristics. The cottonseed isolate is acid soluble and can be incorporated into citric acid-base beverages (Figure 3). In this form, it also has outstanding whipping characteristics and can be used to replace the milk solids used in a gelatin chiffon pie (Figure 4).

We are also interested in the texurization of the LCP flour which will not occur in the same manner as with the isolate. We plan to continue support of the research at Texas A&M on the extrusion characteristics of LCP flour initiated by Cotton Incorporated. Ultimately, this work should provide a product which can be used to extend hamburger in a manner similar to textured vegetable protein products from soy.

Though much information has been developed, there is a need for much more. We need further understanding of the basic nature of cottonseed proteins. Also, there is some indication that for certain end uses, color of the isolate may be a problem. Presently, we are working on the isolation and identification of the nongossypol pigments which in the storage isolate may produce flavor and color problems. Also, as the LCP flour becomes commercially available, needs for information and problem solving will develop which we hope to meet promptly.

At this point, I would like to refer back to Dr. Carter's opening remarks. I would like to emphasize that though we have a new name, our attitude remains the same, that is, a genuine desire to cooperate in every way and in every area where we can be of assistance in furthering the solution of the problems and development of the potential of cottonseed.

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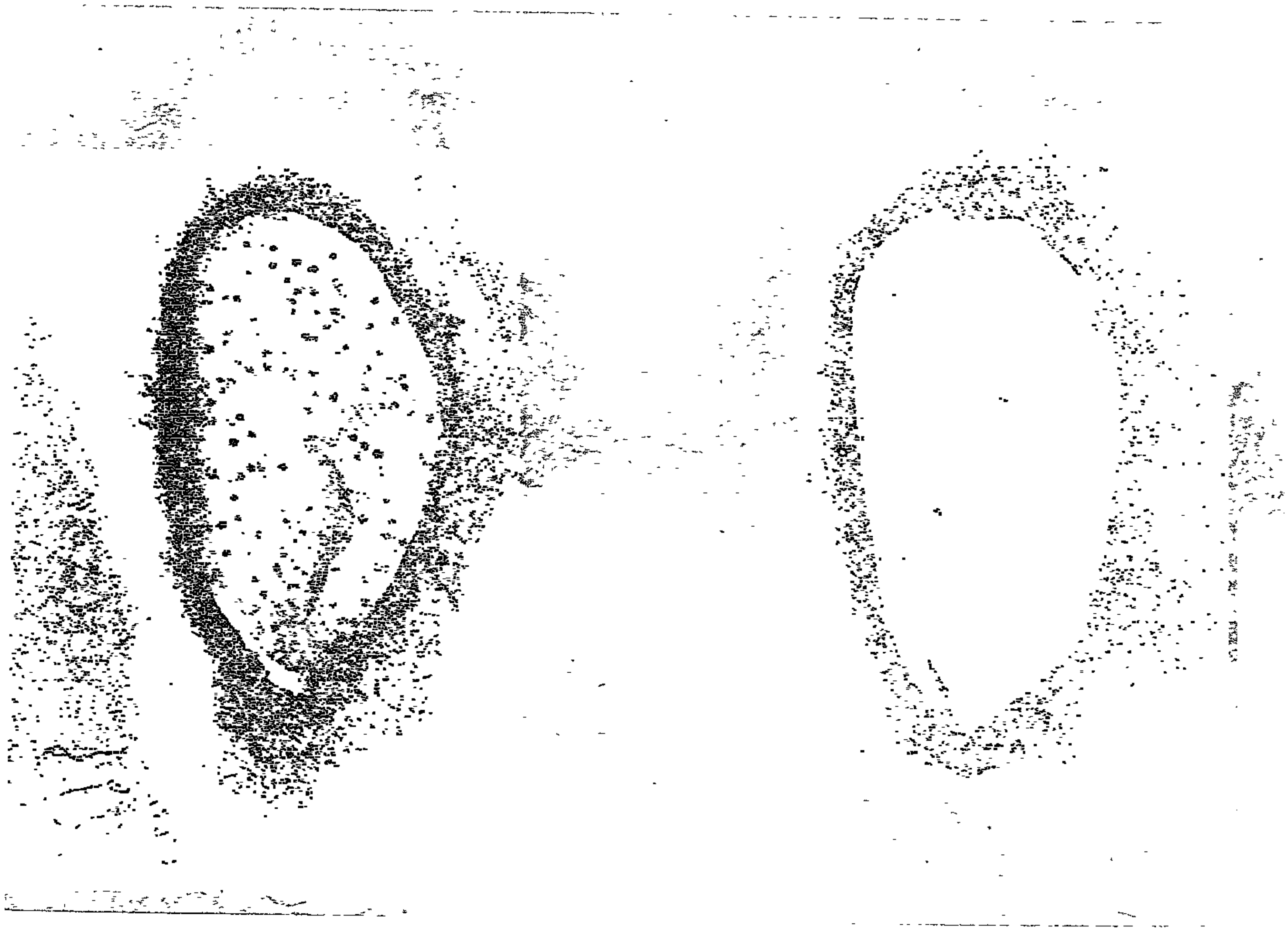

Figure 1.--Longitudinal sections of glandless and glanded, ginned cottonseed

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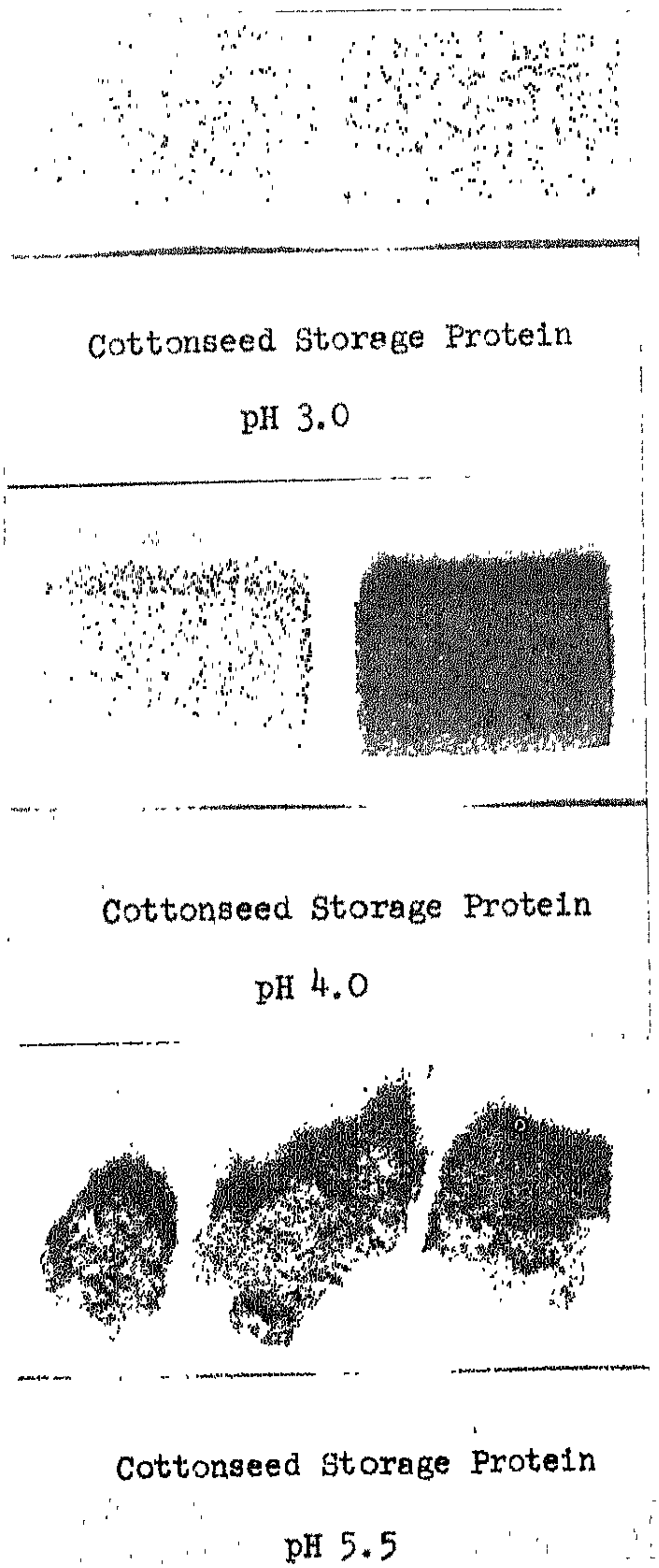

Figure 2.--Range of textures produced by heating aqueous dispersions of the cottonseed storage protein isolated at different pH values.

Figure 3.---Protein punch - 2% cottonseed storage protein isolate in Rio Punch (grapefruit juice, lemon juice and strawberry puree).

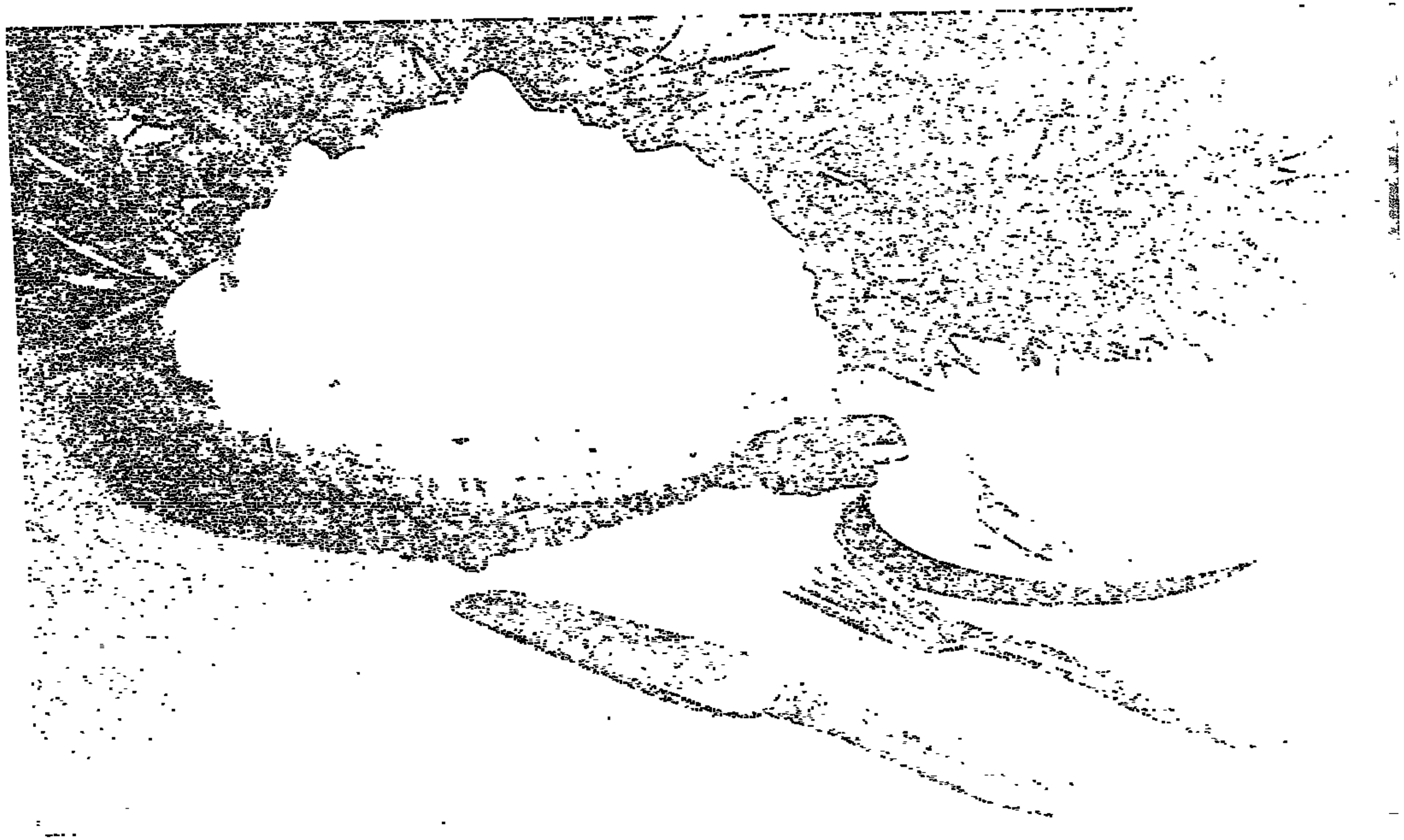

Figure 4.--Gelatin chiffon Pie - one cup of punch replaced one cup of milk in standard recipe.

CURRENT RESEARCH AT SRRC
RELATED TO LIQUID CYCLONE PROCESS

By Homer K. Gardner, Jr.[1]

An overview of the Liquid Cyclone Process is presented for those who are attending the Oilseed Processing Clinic for the first time.

In preliminary evaluations, acid delintered cottonseed kernels and conventionally delintered kernels from the Texas high-plains processed in the liquid cyclone similarly. The flours produced from both types of kernels were essentially the same in physical and chemical analyses.

LCP flour produced at SRRC is being used in an evaluation of the nutritiona status of cottonseed protein in the diets of children. This research is being conducted at Texas Woman's University under contract with the USDA. The current status of the research is reported.

Research to broaden the scope of the LCP to peanuts has been initiated. Progress will be described.

INTRODUCTION

Before I report on current research highlights related to the Liquid Cyclon Process (LCP), I would like to review the process for the benefit of those who may not be familiar with it.

As we see the process, it is an adjunct or satellite food processing operation to a relatively large cottonseed extraction plant. Our main reasoning for this concept is that the process utilizes only the whole and cracked meats fraction essentially hull free produced from hulling prime cottonseed. The remainder of the meats, the fine meats fraction, contains a relatively large percentage of small hull particles and a high bacteria count and would of necessity have to be processed into meal and oil by the parent extraction plant. An LCP plant designed to produce 10 tons of flour per day would require the whole and cracked meats produced from about 90-95 tons of undelintered cottonseed. How do we arrive at this figure? In round numbers, the meats entering the LCP process produce about 34% oil, 33% high-protein flour, and 33% high gossypol meal. Then for a plant producing 10 tons of flour, it would require about 30 tons of whole and cracked meats. Assuming a 50% yield of total meats from undelintered seed and 65% yield of whole and cracked meats from hulling operations, a total of 90-95 tons of undelintered seed is required.

Figure 1 depicts a schematic flow diagram of our pilot plant LCP. To briefly review the process, whole and cracked cottonseed meats, essentially hull free, are dried with 180°F air to a moisture content of about 1 1/2%. These dried meats are next milled in a wide chamber, impact type pin mill with minimal fragmentation of the gossypol pigment glands. The full-fat milled meats are then slurried with hexane to produce a slurry containing 22% solids and pumped to an agitated cyclone surge-feed tank. This slurry is then pumped under an optimum pressure of 40 psig to the heart of the process, the liquid cyclone.

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The products of the cyclone are two slurries, an overflow containing 12-15% high-protein, gland-free solids, and an underflow containing 42-45% solids made up of the pigment glands, hulls, and coarse meats. The solids from both slurries are recovered by filtration. The overflow solids--all less than 40 microns in diameter--are recovered by a rotary, vacuum drum-type filter. The underflow can be recovered by a vacuum pan-type filter. In each of these operations oil is removed from the filter cakes by hexane displacement washes. The high protein cake product contains about 35% volatiles and less than 1% lipids. Desolventization of the high-protein cake is carried out in a SS, jacketed, twin-shell blender equipped for vacuum and solvent recovery operations. When the flour temperature reaches 180°F, most of the solvent has been removed and a nitrogen gas purge is then initiated to strip solvent from the flour to a level below 50 ppm. During stripping the temperature of the flour is allowed to rise to 200°F after which the temperature is reduced to 110°F and the flour discharged into polyethylene bags. The reason for increasing the temperature to 200°F is to improve bacterial kill. The 200°F temperature has little to no effect on protein quality or flour color because of the low flour moisture content of about 3%.

To meet OSHA and EPA regulations the oil mills are under pressure to eliminate dust and lint particulate matter in their operations as pointed out by Dr. Carl Cater yesterday. The major sources of dust and lint particulate are from cleaning and delintering. Therefore, acid-gas delintering is being studied as an alternate to conventional saw delintering. We are concerned as to what effect this type of operation will have on the processability and protein and oil quality of the cottonseed selected for LCP flour production. With this in mind, Jim Ridlehuber from Plains Cooperative Oil Mill prepared two samples of meats from the same lot of cottonseed. One sample of meats was obtained from conventionally delintered seed and the other from acid-gas delintered seed. In order to facilitate hull removal, the seed treated with acid-gas were not completely delintered. Both samples of cottonseed meats were then processed in the same manner in our pilot plant LCP. The yields of high-protein solids from both meat samples were 45% each based on total feed solids. The chemical analyses of the flour produced from the two samples of meats were also essentially the same as the analyses in Figure 2 of LCP flour. Their product flours were bland in flavor and no discernable differences in color were noted.

Nutritional indices such as protein efficiency ratios, amino acid profiles, and vitamin and mineral analyses have been determined for LCP cottonseed flour. To extend this work, research is underway to develop information on the human food value of cottonseed protein products through nutritional status studies with growing children fed diets containing LCP flour. This work is being conducted at Texas Woman's University headed by Dr. Betty Alford under a contract with USDA. The research is being conducted under the hypotheses that cottonseed protein can be fed in a mixed diet to growing children and will support adequate growth and development. The first part of the research dealt with developing acceptable institutional recipes using large quantities of the LCP flour in order to guarantee substantial intake of the flour by the experimental children. During this period data on anthropometry, bone density, and hematology were gathered from the children in the experimental group. Similar data were collected on a control group of children who were not fed the cottonseed protein containing diet. Children in the experimental group were fed a diet containing a moderate level of protein (1 g/Kg of body weight), one-third of which was derived from the LCP flour, over a 6-month period. Tested under acceptable conditions, this diet was satisfactory for growth and development. The experimental group of children fed the diet containing the cottonseed

protein exhibited a significant increase in height over the control group. Th possibility was considered that cottonseed protein, along with other factors, contributed to this change, but no conclusions were drawn. During the next 6-month test period which is now underway, the protein in the mixed diet has been increased to 2 grams of protein per kilogram body weight, thus doubling the cottonseed protein fed to the children from 0.3 to 0.6 g/Kg body weight. At the end of this period, the physiological indices will be reevaluated. Should the increased height indice persist it will probably be the subject of additional research effort.

To broaden the scope of the LCP, two exploratory pilot plant runs have bee made using unblanched peanuts, one with runner peanuts and the other with south west Spanish peanuts. The unblanched peanuts were dried to about 3% moisture content, cracked, flaked, slurried with hexane, and pumped through a Morehouse stone mill. The milled slurry was then pumped through a liquid cyclone to produce a white flour overflow fraction and an underflow fraction containing all of the skins. In general, the uses for the two products would be similar to the ones for the fine and coarse fractions obtained by air-classification of extracted and milled peanuts. The overs flour fraction containing about 66-68% protein can be used to fortify bread, other light-colored bakery items, and beverages. The coarse unders fraction, which is darker because it contains skins, contains about 50% protein and may be used in ground meat recipes. This is an indication of the versatility of the Liquid Cyclone Process and this versatility will probably extend to other oilseeds and/or oil bearing materials.

LIQUID CYCLONE PROCESS

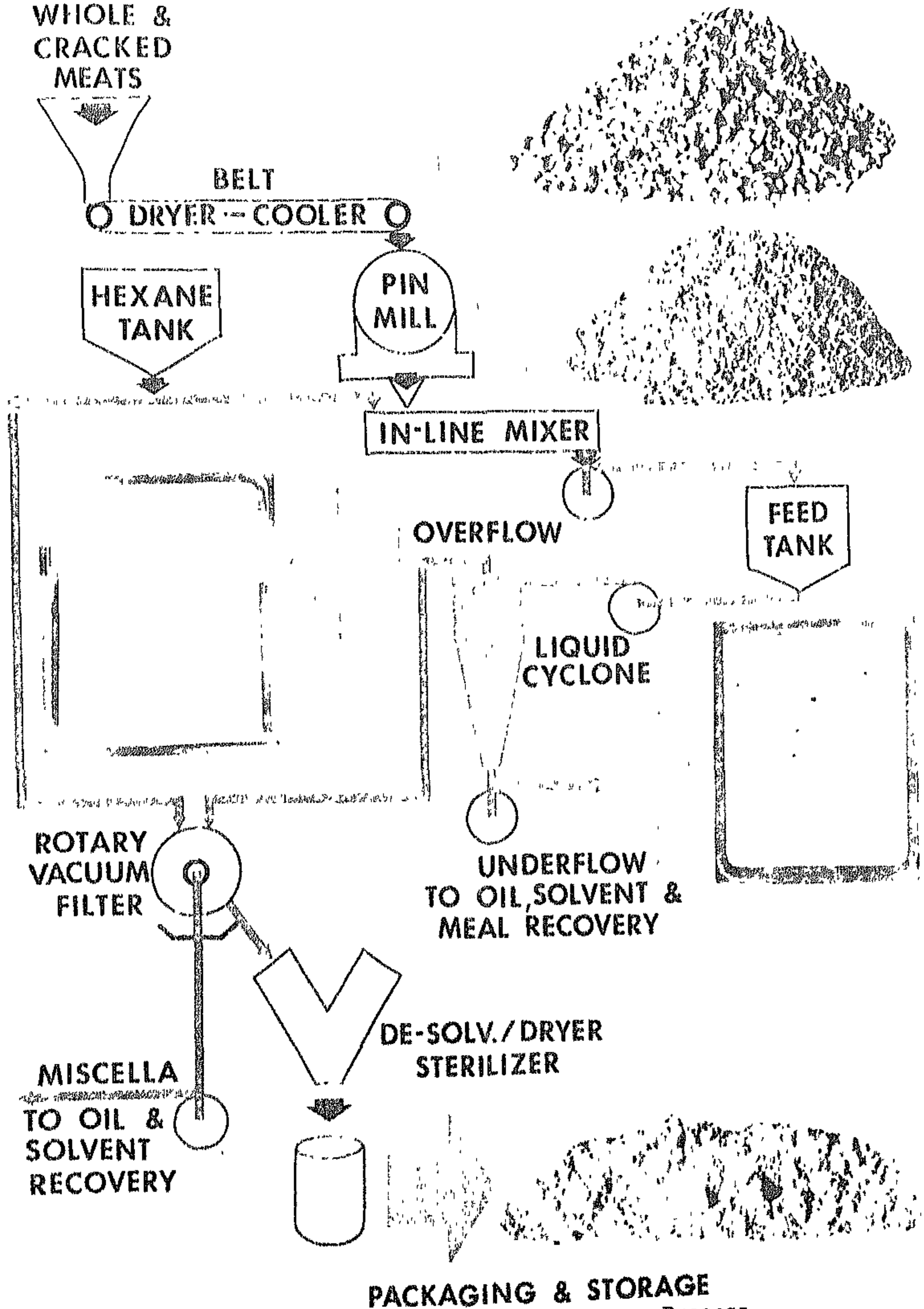

Figure 1.--Schematic flow diagram of Liquid Cyclone Process.

LCP COTTONSEED FLOUR

TYPICAL CHEMICAL ANALYSES

MOISTURE, %	3.66
LIPIDS, %	0.62
FREE GOSSYPOL, %	0.03
TOTAL GOSSYPOL, %	0.12
NITROGEN, %	10.54
PROTEIN, (MFB), (N x 6.25), %	68.40
N, SOLUBILITY, (0.02 N NaOH), %	99.49
LYSINE, (g/16g N)(EAF)	3.94
FIBER, %	2.4
ASH, %	7.54
HEXANE, (PPM)	35

Figure 2.--Chemical analyses of a Liquid Cyclone Process cottonseed flour.

PROGRESS REPORT ON THE LIQUID CYCLONE PROGRESS--COMMERCIAL STARTUP

By Jim Ridlehuber[1]

When I consented last fall to make a presentation on commercial startup the liquid cyclone plant, it was expected by everyone that by now the plant uld be in full production. Since the plant is not in operation, the title of talk more aptly should have been "Problems in Attempting Commercial Startup."

It has been my privilege to work closely during the past four years with e Southern Regional Research Center in making the production of Cottonseed otein concentrate a commercial reality. The liquid cyclone process has been scribed at this meeting several times and the process as developed is still valid and reasonable process. We have to understand, however, that when we .ke a process that works consistently in a laboratory and pilot scale tests, en it is still a difficult and time consuming task to build a plant to bring e process to a full scale commercial production. We fully agree with '. Carter's statement in the welcoming address to this meeting that when a .andless cottonseed variety becomes available the liquid cyclone process will : used to produce two edible fractions.

Plains Cooperative Oil Mill has built a plant that will not only be the .rst of its kind, but one that we can be proud to show to anyone. We have ɔared no expense in making our facility truly a food plant. During the past even months we have made enough test runs to prove that the basic equipment ɔr the liquid cyclone plant is workable.

Some mistakes were made in selection of equipment. The flour, because of ;s very fine particle size is difficult to convey and handle. We have found : necessary to re-engineer portions of the plant and order different equipment ɔ replace portions of handling equipment that we originally assumed would handle ıe product. We have been delayed and hampered by material and equipment short- ges, and are now awaiting new equipment that we feel will resolve our problems. e have spent 3 1/3 million dollars on the plant so far, and expect that about million will have to be the total figure spent, with about one million tied p in equipment that did not work and will have to be replaced. Such problems re normally expected with radically new commercial installations.

(A group of 21 slides were shown with views of the plant buildings and quipment to illustrate the food grade emphasis for equipment.)

We make no apologies for the plant not being in operation. I am glad to e associated with a company and management that has shown patience and tolerance ith the problems and delay encountered in plant startup. Our company at the east has enough foresight to be willing to risk our money in developing a new rocess that will not only be an asset to the entire cottonseed industry but a ew source of nutritional protein food for the world needs.

[1] Chief Chemist, Plains Cooperative Oil Mill, Lubbock, Texas 79408.

AUTOMATION OF A SOLVENT EXTRACTION AREA

C. Louis Kingsbaker, Jr.[1]

Today when we think or hear of the word "Automation," we immediately picture a large computer taking over the entire operation of a system or plant. Once the computer is programmed, then all of the labor required to run the plant will be handled by the computer and all the work we must do is watch that the computer functions properly. I certainly wish that such a method could be used in running a solvent extraction plant, but I do not think we will live to see this happen in our lifetime.

There are several reasons for making this statement. First of all, most extraction areas are run by one operator. Because of union rules, you will not be permitted to eliminate this operator. So if you can not eliminate that operator, why try to computerize your plant. Even if you could eliminte this man, you would have to replace him with a more skilled one to monitor the computer operation and to maintain the computer. Second, I do not believe an extraction plant, due to the nature of the operation, would lend itself to computerization since you are handling solids, liquids and gases. This not true, for example, in the petroleum industry where you are handling basically liquids and gases.

I do, however, think that extraction plants can be automated to a far greater extent than they are at the present time and I am certain very shortly you will see this happen. Two years ago, Stanley Kampany made his famous "We ain't got no money" speech to this group in which he said expansion and modernization could not be accomplished because of the poor earnings of the industry. However, in the past two years you have seen operating margins increase dramatically so that there now is money available to invest in automating plants. In the past two years, you have also seen:

1. The quality and the availability of plant operators decrease. Good people are just hard to find and keep.
2. The cost of labor increase.
3. The cost of solvent almost triple, and it will go even higher.
4. The availability of solvent become uncertain and without it you can not run. It is imperative that you reduce solvent losses.
5. Downtime due to operator error which now can not be tolerated.
6. The cost of energy to generate steam increase, and it will continue to do so.
7. The threat of governmental shutdown because of the Environmental Protective Agency and the Occupational Safety and Health Act.

We are running our extraction plants today under drastically different conditions than we have been accustomed and to stay in business and be profitable, we must change our plant design concepts.

I started my talk with a theoretical definition of automation. Now I would like to give you my definition of automation in a solvent extraction plant. It is "Use of instruments, controllers, alarms and design and operating philosophy so that a poor operator can run a plant efficiently, safely and economically to make quality meal and oil."

[1]Blaw-Knox Chemical Plants Division, Dravo Corporation, Pittsburgh, Pa. 15222.

The automatic sequencing electrical system used here, in my opinion, is not necessary to automate an extraction plant. I would want to invest my money differently. It is also too complicated and difficult to maintain.

I have presented what has been done in the past to automate extraction plants. Now I want to offer my ideas and requirements for automating the extraction area. Consideration is given to the fact that most plants are in rural areas and that systems would have to be maintained by plant personnel. My system would only require that a trained instrument maintenance man be added to your staff. You would also have to provide dry, clean instrument air. The automated plant I would provide would include the following:

1. Graphic panel board located at the extractor operating level.
2. Ammeters for all motors driving solids handling equipment plus other vital motors all located on the graphic panel board.
3. Recording controllers, panel mounted for temperature, pressure, and flow. Recorders for level controllers would not be required, but would be panel mounted. All of these instruments would be pneumatic, and located by the graphic panel at the extractor operating level.
4. A specific gravity recorder for miscella. This will give better extractor operating efficiency and also reduce steam consumption.
5. An automatic level controller for the desolventizer-toaster.
6. A valve to automatically stop steam to the extraction plant in case of cooling water failure. The snuffing steam required by NFPA Booklet No. 36 would be provided in a separate line.
7. A low pressure alarm in the cooling water header to indicate loss of cooling water.
8. A pressure switch in the fresh solvent line to the extractor to sound an alarm and then five minutes later if the problem has not been corrected, to shut down the plant in case the flow of solvent stops.
9. A temperature recorder and low temperature alarm for the oil from the oil stripper.
10. A vacuum recorder and low vacuum alarm for the bottom of the oil stripper.
11. A temperature recorder and low temperature alarm for the meal leaving the desolventizer.
12. A low temperature alarm for the mineral oil leaving the mineral oil stripper.
13. A low temperature alarm for the water leaving the waste water evaporator to the sewer.
14. A high temperature alarm for the mineral oil leaving the mineral oil absorber.
15. A high pressure alarm for the pressure in the extractor and mineral oil absorber.
16. A valve to automatically turn off steam to the desolventizer-toaster and meal dryer in case of plant shut down. This prevents meal fires.
17. A pneumatically operated slide gate located in the spout to the extractor feed conveyor interlocked so it will close when the plant stops. This protects against vapors getting back to the preparation building during shut downs and plant startups.

The above list is neither imposing nor excessively costly. It is designed to automate the plant from a central panel and to control and monitor each product and effluent stream. It is designed to give the plant manager a daily

I would briefly like to review what has been done in the past to achieve these goals:

1. In 1948 and 1950, the Glidden Company and Spencer Kellogg Company built extraction plants that could be controlled from a central panel board using control instrumentation. However, due to cost, the use of panel control instruments has been mostly eliminated. Incidentally, both of these companies are out of the extraction business. United States plants now use a minimum of control instruments and these are all locally mounted. To my knowledge, graphic panel boards in the extraction area are not used.

2. Most Japanese and European plants use graphic panel boards for both the preparation and extraction areas. The panel board in the extraction area usually shows only the motor-driven equipment. If a motor fails, its light on the panel board flashes to show the operator which motor has stopped. You will note from the slide that there are no control instruments on this panel. At this plant some unique ideas were used. All of the recording control instruments, and they were used extensively throughout the plant, were located at the plant operating platform of the "Rotocel" extractor and grouped by unit operation systems. Also, all the valves for the plant including by-passes were located at the extractor operating platform level. This meant that the operator could run the plant on one level of the plant and monitor all of the instruments. Ammeters were provided for all motors. The preparation area was also similarly controlled.

Recently, this company has installed four television cameras in the extraction building and has placed television receivers in the preparation building control room. They monitor the panel board, some instruments and the level in the desolventizer-toaster.

3. A new plant was started in Germany last year that took a different approach. A central control room was built between the extraction and preparation building with a unique graphic panel board for both the preparation and extraction areas. Some ammeters and recording instruments were provided. Plant startup was done using a sequence relay electrical system. To startup, the following was done:

a. Push the alarm button to warn everybody that the plant was starting.
b. Five seconds later, if all relays were functional, a "Proceed" light would light.
c. A single start switch was activated manually and by automatic sequence, the entire system would start, up to an including the conveyor under the flaking mills. Five of the nine flaking mills were manually started and the start switch was again activated. The system starts again automatically to the conveyor under the cracking mills. Three of the five cracking mills were manually started and again the start switch was turned. The balance of the equipment started automatically and soybeans would begin to flow.
d. As elaborate as this system is, they did not install an alarm horn in the plant, only in the control room. If you were in the plant during shutdown, you did not know that the plant had a shutdown.
e. The electrical system was so complex, that the owner had to hire electricians for a six-month period from the electrical company who had installed it, until they could train their own people. You may observe from the slide that the panel board is of translucent construction with square openings to plug in the running lights. This is an excellent way to build a graphic panel. It is inexpensive and very easy to change or add to.

record, made by an instrument, of each product stream. It eliminates relying on "fudged" operator log sheets where the operator tries to cover up his mistakes. It warns against operating conditions when solvent might be lost. It provides for an automatic, safe, emergency shutdown. It gives the extraction industry an automated plant so that by the use of instruments, controllers, alarms and design and operating philosophy a poor operator can run a plant efficiently, safely and economically to make quality meal and oil.

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